U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-292 268

Health Effects of Human Exposure to Barium in Drinking Water

Illinois Univ at the Medical Center, Chicago

Prepared for

Health Effects Research Lab, Cincinnati, OH

Jan 79

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1. REPORT NO.
EPA-600/1-79-003

2.

3. RECIPIENT'S ACCESSION NO.
PB292268

4. TITLE AND SUBTITLE
Health Effects of Human Exposure to Barium in Drinking Water

5. REPORT DATE
January 1979 issuing date

6. PERFORMING ORGANIZATION CODE

7. AUTHOR(S)
Gary R. Brenniman, W. H. Kojola, P. S. Levy, B. W. Carnow, T. Namekata and E. C. Breck

8. PERFORMING ORGANIZATION REPORT NO.

9. PERFORMING ORGANIZATION NAME AND ADDRESS
The University of Illinois at the Medical Center
Chicago, Illinois 60612

10. PROGRAM ELEMENT NO.
1CC614

11. CONTRACT/GRANT NO.
R-803918

12. SPONSORING AGENCY NAME AND ADDRESS
Health Effects Research Laboratory - Cinn, OH
Office of Research & Development
U.S. Environmental Protection Agency
Cincinnati, Ohio 45268

13. TYPE OF REPORT AND PERIOD COVERED
Final - 8/12/75 to 10/31/78

14. SPONSORING AGENCY CODE
EPA/600/10

15. SUPPLEMENTARY NOTES

16. ABSTRACT

The overall objective of this study was to examine by epidemiologic and supportive laboratory studies, the human health effects associated with ingestion of barium in drinking water exceeding the U.S. drinking water standard of 1.0 mg/1.

The incidence of cardiovascular mortality and/or the prevalence of various cardiovascular, cerebrovascular and renal diseases was compared between communities with barium concentrations exceeding the drinking water standard, and communities which have negligible barium in their drinking water. Mortality rates for cardiovascular diseases were retrospectively determined for the years 1971-1975. A comparison between communities with elevated barium levels (>2 mg/1) and communities with low or no barium (<0.2 mg/1) in their public water supplies did show higher mortality rates for the exposed population.

The prevalence of various cardiovascular, cerebrovascular and renal diseases in two communities having similar socioeconomic characteristics and different concentrations of barium in their drinking water (mean barium concentration of 7 mg/1 in water supply of exposed population as compared to 0.1 mg/1 in the control) was determined through an epidemiology study. Results of the study revealed significant differences in blood pressure between the two communities and especially in the male population exposed to barium when the data were refined to correct for the influence of water softening, blood pressure medication, hypertension and duration of exposure.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Ingestion (biology) Barium Socioeconomic status Epidemiology Mortality Morbidity Ground water Potable water	Health Effects Epidemiology Study	68G

18. DISTRIBUTION STATEMENT Release to Public	19. SECURITY CLASS *(This Report)* Unclassified	21. NO. OF PAGES 143
	20. SECURITY CLASS *(This page)* Unclassified	22. PRICE A07- A01

☆ U. S. GOVERNMENT PRINTING OFFICE: 1979 — 657-060/1574

United States
Environmental Protection
Agency

Health Effects Research
Laboratory
Cincinnati OH 45268

EPA-600/1-79-003
January 1979

PB 292268

Research and Development

EPA

Health Effects of Human Exposure to Barium in Drinking Water

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

RESEARCH REPORTING SERIES

Research reports of the Office of Research and Development, U.S. Environmental Protection Agency, have been grouped into nine series. These nine broad categories were established to facilitate further development and application of environmental technology. Elimination of traditional grouping was consciously planned to foster technology transfer and a maximum interface in related fields. The nine series are:

1. Environmental Health Effects Research
2. Environmental Protection Technology
3. Ecological Research
4. Environmental Monitoring
5. Socioeconomic Environmental Studies
6. Scientific and Technical Assessment Reports (STAR)
7. Interagency Energy-Environment Research and Development
8. "Special" Reports
9. Miscellaneous Reports

This report has been assigned to the ENVIRONMENTAL HEALTH EFFECTS RESEARCH series. This series describes projects and studies relating to the tolerances of man for unhealthful substances or conditions. This work is generally assessed from a medical viewpoint, including physiological or psychological studies. In addition to toxicology and other medical specialities, study areas include biomedical instrumentation and health research techniques utilizing animals — but always with intended application to human health measures.

This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.

EPA-600/1-79-003
January 1979

HEALTH EFFECTS OF HUMAN EXPOSURE TO BARIUM IN DRINKING WATER

by

G.R. Brenniman, W.H. Kojola, P.S. Levy,
B.W. Carnow, T. Namekata and E.C. Breck
The University of Illinois at the
Medical Center
Chicago, Illinois 60612

Grant No. R803918

Project Officer

Edwin C. Lippy
Field Studies Division
Health Effects Research Laboratory
Cincinnati, Ohio 45268

HEALTH EFFECTS RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268

ia

DISCLAIMER

This report has been reviewed by the Health Effects Research Laboratory, U.S. Environmental Protection Agency, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the U.S. Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

FOREWORD

The primary mission of the Health Effects Research Laboratory is to provide data which are based on health-related research to support the regulatory activities of the Environmental Protection Agency. Research data are used in the Agency's standards setting procedures to insure that man and his environment are protected.

The objectives of the investigation reported herein were to determine whether health effects could be identified in a population exposed to barium in their drinking water. The investigation consisted of an analysis of death rates for communities exposed to barium at a concentration of 2 mg/l or greater as opposed to those with no significant exposure. This analysis showed higher death rates for the communities exposed to barium. The investigation also included a comparison of health data that was collected by household survey from nearly 2,400 people living in two communities whose water supply contained 7 mg/l (West Dundee) and 0.1 mg/l of barium (McHenry) respectively. The comparison of health data showed significant differences in blood pressure with higher readings notable in the male population of West Dundee when the data were refined to correct for the influences of water softening, blood pressure medication, hypertension, and duration of exposure.

The investigators emphasize that the analysis of death rates must be interpreted with caution because of factors that could not be controlled including a greater population change in the high barium communities and the use of home water softeners. They further noted that their household survey data were inconclusive because the blood pressure elevations were not consistent for the total West Dundee population and that additional study was necessary.

This study did not produce a distinctive conclusion that permits us to recommend a safe standard for barium in drinking water. However, the differences identified in death rates at a barium concentration of greater than 2 mg/l and the elevation in blood pressures at 7 mg/l are of primary public health concern. We agree that further study is necessary and plan to conduct a morbidity survey of a population exposed to 2 mg/l of barium in drinking water in order to better identify a no-effect level. In the interim, we do not think it is advisable for the current barium limit of 1 mg/l to be relaxed and we think that communities exceeding the MCL should proceed with plans to reduce barium exposure and avoid the possibility of the occurrence of adverse health effects.

R. J. Garner, M.A., DVSc, FRCVS, ARIC
Director
Health Effects Research Laboratory

ABSTRACT

The overall objective of this study was to examine by epidemiologic and supportive laboratory studies, the human health effects associated with ingestion of barium in Illinois drinking water exceeding the maximum contaminant level (MCL) for barium of 1.0 mg/l as stipulated in the National Interim Primary Drinking Water Regulations (NIPDWR). This study is the first of its kind to assess the chronic human health effects associated with ingestion of elevated barium levels in drinking water.

A retrospective epidemiological analysis of age and sex-adjusted cardiovascular death rates for the years 1971-1975 was conducted to examine differences between Illinois communities with elevated drinking water barium levels (>1.0-10.0 mg/l) and communities with little or no barium (0.0-0.2 mg/l). Results of the mortality study revealed that the high barium communities had significantly higher ($P < 0.05$) death rates for "all cardiovascular diseases" and "heart disease" compared to the low barium communities. Since there was a greater population change in some of the high barium communities compared to the low barium communities and no method of controlling for removal of barium by home water softeners, any inferences drawn about this finding must be interpreted with caution.

A morbidity study was conducted in West Dundee, and McHenry, Illinois to examine whether or not there are differences in mean blood pressure levels and the prevalence of hypertension, cardiovascular, cerebrovascular and renal disease between the populations of these two communities. The major difference between the two communities is that West Dundee has a mean barium concentration in its drinking water approximately 70 fold greater than that found in McHenry's drinking water. Although some significant differences ($P < 0.5$) were found for mean age and sex-adjusted levels of systolic blood pressures between the high barium and low barium communities, the blood pressure data were inconclusive because of inconsistencies in the findings. For instance, a significant difference was found for females living 10 years or less in the community, while no difference was found for females living greater than 10 years in the community. A significant difference was found for males living greater than 10 years in the community when the data were corrected for water softeners and high blood pressure medication. Female blood pressures were not significantly different under these circumstances. Finally, no significant differences were found between the two communities with respect to the prevalence of hypertension, heart disease, stroke, or kidney disease.

This report was submitted in fulfillment of Grant No. R-803918 by the University of Illinois, School of Public Health, Chicago, under the sponsorship of the U.S. Environmental Protection Agency. This report covers the period August 11, 1975 to October 31, 1978.

CONTENTS

Foreword iii
Abstract iv
Figures. vi
Tables vii
Acknowledgments. xiii

1. Introduction. 1
2. Conclusions 2
3. Recommendations 3
4. Background Information. 4
    Water data. 4
    Toxicity. 4
    Metabolism. 6
    Cardiovascular effects. 6
    Hormonal system effects 7
    Epidemiological studies 8
    Barium water standard 8
5. Project Design and Methodology. 9
    Mortality methodology 9
    Morbidity methodology 16
    Analytical procedures 20
    Statistical procedures. 21
6. Results and Discussion. 22
    Mortality study 22
    Morbidity study 27
        Characteristics of populations studied 27
        Health indicies. 30
        Refusals 72
        Water sample analysis. 72
        Drinking water sodium concentrations and blood pressure levels. 89
        Drinking water sodium concentrations and prevalence rates of heart disease, hypertension, stroke and kidney disease 89

References 98

Appendices

A. Household listing and survey of minerals and health 104
B. Letter to refusals. 120
C. Standard Illinois population and age-specific death rates . . . 121
D. Mantel Haenszel test. 125

FIGURES

Number Page

1 Mean age-specific systolic and diastolic blood pressure among males 18-75+ years of age: West Dundee and McHenry,Illinois, 1976-77. . . 36

2 Mean age-specific systolic and diastolic blood pressure among females 18-75+ years of age: West Dundee and McHenry,Illinois, 1976-77. 37

3 Mean age-specific systolic and diastolic blood pressure among males 18-75+ years of age who have lived greater than 10 years in: West Dundee and McHenry, Illinois, 1976-77 40

4 Mean age-specific systolic and diastolic blood pressure among females 18-75+ years of age who have lived greater than 10 years in: West Dundee and McHenry, Illinois 1976-77. 41

TABLES

Number Page

1 Elevated Barium Levels in Illinois Drinking Water 5

2 Characteristics of Persons in Illinois Communities With 2.0 mg/l Barium or Greater in Their Drinking Water 10

3 Characteristics of Persons in Illinois Communities With 0.2 mg/l Barium or Less in Their Drinking Water 11

4 High and Low Barium Communities Used for Mortality Study 13

5 Eighth Revision International Classification of Diseases 14

6 Population Information by Age Group 15

7 General Characteristics of Persons Residing in West Dundee or McHenry, Illinois 17

8 Occupations of Persons Residing in West Dundee or McHenry, Illinois 18

9 Age-Adjusted Death Rates for Cardiovascular Diseases in High and Low Barium Communities 23

10 Age-Adjusted Death Rates for Cardiovascular Diseases in the City of DeKalb and Low Barium Communities 24

11 Age-Adjusted Death Rates for Cardiovascular Diseases in High Barium Communities, the City of DeKalb, Low Barium Communities, and the Average Death Rates Between 1970 and 1975 for the Illinois Population 25

12 Death Rates for Cardiovascular Diseases in the State of Illinois .. 26

13 Ages and Residence Times of Persons in West Dundee and McHenry 28

14 Characteristics of White Persons 18 Years Old and Over Residing in West Dundee and McHenry 29

15 Mean Number of Visits to a Doctor's Office for West Dundee and McHenry Residents 31

Tables (cont.)

Number Page

16 Mean Number of Days Spent in a Hospital For West Dundee and McHenry Residents 32

17 Mean Number of Days Away from Work or Unable to Carry Out Usual Activities for West Dundee and McHenry Residents 33

18 Mean Blood Pressures for West Dundee and McHenry Residents 35

19 Mean Blood Pressures for Persons Living in the United States 38

20 Mean Blood Pressures for Persons Living in West Dundee or McHenry, > 10 Years 39

21 Mean Blood Pressures for Persons Living in West Dundee for ≤ 10 Years or For > 10 Years 42

22 Mean Blood Pressures for Persons Living in McHenry for ≤ 10 Years or for > 10 Years 43

23 Mean Blood Pressures for Persons Living in West Dundee or McHenry ≤ 10 Years 44

24 Mean Blood Pressures for Persons Living in West Dundee or McHenry > 10 Years and Are not Taking Blood Pressure Medication 46

25 Mean Blood Pressures for Persons Living in West Dundee or McHenry ≤ 10 Years and Are Not Taking Blood Pressure Medication 47

26 Mean Blood Pressures for Persons Living in West Dundee or McHenry > 10 Years, Who Do Not Have Hypertension and Are Not Taking Blood Pressure Medication 48

27 Mean Blood Pressures for Persons Living in West Dundee or McHenry ≤ 10 Years, Who Do Not Have Hypertension and Are Not Taking Blood Pressure Medication 49

28 Mean Blood Pressures for West Dundee and McHenry Residents Who Do Not Have Hypertension Nor are Currently Taking Blood Pressure Medication 50

29 Mean Blood Pressures for West Dundee and McHenry Residents Who Have Definite Hypertension or are Currently Taking Blood Pressure Medication 51

30 Mean Blood Pressures for West Dundee and McHenry Residents Who are on High Blood Pressure Medicine 52

Tables (cont.)

Number Page

31 Mean Blood Pressures for West Dundee and McHenry Residents Who No Longer are Taking High Blood Pressure Medicine 53

32 Mean Blood Pressures for West Dundee and McHenry Residents Who Do Not Have Home Water Softeners 55

33 Mean Blood Pressures for Persons Who Do Not Have Water Softeners and Have Lived in West Dundee or McHenry for > 10 Years 56

34 Mean Blood Pressures for Persons Who Do Not Have Water Softeners and Have Lived in West Dundee or McHenry for ≤ 10 Years 57

35 Mean Blood Pressures for Persons Living in West Dundee or McHenry Who Do Not Have Water Softeners and Are Not Taking Blood Pressure Medication 58

36 Mean Blood Pressures for Persons Who Do Not Have Water Softeners, Are Not Taking High Blood Pressure Medication and Have Lived > 10 Years in West Dundee or McHenry 59

37 Mean Blood Pressures for Persons Who Do Not Have Water Softeners, Are Not Taking High Blood Pressure Medication and Have Lived ≤ 10 Years in West Dundee or McHenry 60

38 Mean Blood Pressures for Persons Living in West Dundee or McHenry Who Do Not Have Water Softeners, Do Not Have Hypertension and Are Not Taking Blood Pressure Medication 62

39 Mean Blood Pressures for Persons Who Do Not Have Water Softeners, Do Not Have Hypertension, Are Not Taking Blood Pressure Medication and Have Lived >10 Years in West Dundee or McHenry 63

40 Mean Blood Pressures for Persons Who Do Not Have Water Softeners, Do Not Have Hypertension, Are Not Taking Blood Pressure Medication and Have Lived ≤ 10 Years in West Dundee or McHenry 64

41 Mean Blood Pressures for West Dundee and McHenry Residents Who Have Never Smoked 65

42 Mean Blood Pressures for West Dundee and McHenry Residents Who Have Smoked Sometime During Their Lifetime 66

43 Mean Blood Pressures for West Dundee and McHenry Residents Who Have Been Determined Obese by Skinfold Readings 67

44 Mean Blood Pressures for West Dundee and McHenry Residents Who Have Been Determined Nonobese by Skinfold Readings 68

Tables (cont.)

Number Page

45 Mean Pulse Rates for West Dundee and McHenry Residents 69

46 Prevalence Rates of Definite Hypertension for West Dundee and McHenry Residents 73

47 Prevalence Rates of Borderline Hypertension for West Dundee and McHenry Residents 73

48 Prevalence Rates of Definite Hypertension for Persons Living in the United States 74

49 Prevalence Rates for West Dundee and McHenry Residents Who Have Definite Hypertension or are Currently Taking Blood Pressure Medication 74

50 Prevalence Rates for West Dundee and McHenry Residents Who Have Had a Stroke 75

51 Prevalence Rates for West Dundee and McHenry Residents Who Have Heart Disease 75

52 Prevalence Rates for West Dundee and McHenry Residents Who Have Diabetes 76

53 Prevalence Rates for West Dundee and McHenry Residents Who Have Kidney Disease 76

54 Mean Blood Pressures of West Dundee and McHenry Residents Who Initially Refused to Participate but Volunteered To Be Part Of The Study When Asked A Second Time 77

55 Analysis of Water Treatment Plant Samples From West Dundee and McHenry 79

56 Proton Induced X-Ray Emission Analysis of Water Treatment Plant Samples From West Dundee and McHenry 80

57 Analysis of Water Samples From West Dundee and McHenry Households With and Without Water Softeners 81

58 Analysis of Water Samples From West Dundee and McHenry Households with Water Softeners 82

59 Analysis of Water Samples From West Dundee and McHenry Households Without Water Softeners 84

60 Analysis of Water Samples From West Dundee and McHenry Households With Sodium Concentrations $\leq$ 25 mg/l 85

Tables (cont.)

Number Page

61 Analysis of Water Samples From West Dundee and McHenry Households With Sodium Concentrations > 25 mg/l 86

62 Analysis of Water Samples From West Dundee and McHenry Households With Sodium Concentrations ≤ 100 mg/l 87

63 Analysis of Water Samples From West Dundee and McHenry Households With Sodium Concentrations > 100 mg/l 88

64 Mean Systolic Blood Pressures for Males From McHenry Who are Exposed to Diverse Sodium Concentrations in Their Drinking Water 90

65 Mean Diastolic Blood Pressures for Males From McHenry Who are Exposed to Diverse Sodium Concentrations in Their Drinking Water 91

66 Mean Systolic Blood Pressures for Females From McHenry Who are Exposed to Diverse Sodium Concentrations in Their Drinking Water 92

67 Mean Diastolic Blood Pressures for Females From McHenry Who are Exposed to Diverse Sodium Concentrations in Their Drinking Water 93

68 Prevalence Rates of Males From West Dundee and McHenry Who Have Heart Disease and are Exposed to Varying Sodium Concentrations in Their Drinking Water 94

69 Prevalence Rates of Females From West Dundee and McHenry Who Have Heart Disease and are Exposed to Varying Sodium Concentrations in Their Drinking Water 94

70 Prevalence Rates of Males From West Dundee and McHenry Who Have Definite Hypertension and are Exposed to Varying Sodium Concentrations in Their Drinking Water 95

71 Prevalence Rates of Females From West Dundee and McHenry Who Have Definite Hypertension and are Exposed to Varying Sodium Concentrations in Their Drinking Water 95

72 Prevalence Rates of Males From West Dundee and McHenry Who Have had a Stroke and are Exposed to Varying Sodium Concentrations in Their Drinking Water 96

Tables (cont.)

Number Page

73 Prevalence Rates of Females From West Dundee and McHenry Who Have had a Stroke and are Exposed to Varying Sodium Concentrations in Their Drinking Water 96

74 Prevalence Rates of Males From West Dundee and McHenry Who Have Kidney Disease and are Exposed to Varying Sodium Concentrations in Their Drinking Water 97

75 Prevalence Rates of Females From West Dundee and McHenry Who Have Kidney Disease and are Exposed to Varying Sodium Concentrations in Their Drinking Water 97

76 Standard Illinois Population (April, 1970) 121

77 Person Years, By Age Groupings and Sex, Used to Calculate Age-Specific Death Rates In Study Communities 121

78 Age-Specific Death Rates For Cardiovascular Diseases For Persons Who Lived in High Barium Communities 122

79 Age-Specific Death Rates for Cardiovascular Diseases For Persons Who Lived in the City of DeKalb 123

80 Age-Specific Death Rates for Cardiovascular Diseases For Persons Who Lived in Low Barium Communities 124

81 Mantel-Haenszel Test With An Illustrative Example From The Study... 126

ACKNOWLEDGMENTS

The Survey Research Laboratory, University of Illinois at Chicago Circle, assisted with questionnaire development, coding, key punching, and cleaning of computer tapes. Computer services used in this research were provided by the University of Illinois at Chicago Circle. Their assistance is gratefully acknowledged.

Permission to use Illinois mortality tapes was given by Joyce C. Lashof, Director, State of Illinois Department of Public Health in 1976. Her cooperation was especially appreciated.

Analysis of the water samples in 1976-77 was conducted by the Illinois Environmental Protection Agency, Chicago Laboratory. James Miller, Manager, Division of Laboratory Services, approved the use of the Chicago Laboratory for this project; John Murray and James Daugherty directed the water analysis; and Pankaj Parikh performed the atomic absorption analysis. Quality control was conducted by the U.S. Environmental Protection Agency, Region V, Central Regional Laboratory, Chicago, under the direction of Thomas Yeates, Richard Ronan, and Edmund Huff. We are especially grateful to Dorothy Bennett, Division of Public Water Supplies, Illinois Environmental Protection Agency, for supplying us with film records of mineral analyses for water treatment plants in Illinois.

A very special acknowledgment goes to our survey workers, LaFern Kuntz, June Detwiler, Lois Stolldorf, and Sheila Bambrick, for their devotion and enthusiasm.

The cooperation of the West Dundee Village Board, McHenry City Council, McHenry County Department of Health and all residents of these two Illinois communities who participated in the study was greatly appreciated.

We are particularly indebted to Edwin Lippy, EPA Project Officer, for his untiring efforts, cooperation, and patience with this project.

Finally, a special thank you should be given to Velma Kuykendall for typing this manuscript.

SECTION 1

INTRODUCTION

The Illinois Environmental Protection Agency (IEPA) has identified several communities in northeastern Illinois which have drinking water sources that exceed the maximum contaminant level (MCL) for barium of 1.0 mg/l as stipulated in the National Interim Primary Drinking Water Regulations (NIPDWR). The standard is exceeded in this area by as much as tenfold and includes an exposed population of more than 150,000 individuals.

The health criteria used in establishing the MCL for barium is based upon an extrapolation from the occupational air standard of 0.5 mg/m^3, which itself incorporates an unknown degree of safety. There are no epidemiological studies which have examined the human health effects associated with barium intake from drinking water.

An examination of the literature on experimental animal studies and human accidental poisonings demonstrates adverse health effects of barium, including stimulation of smooth, striated, and cardiac muscle, vasoconstriction and elevation of blood pressure, rapid and preferential deposition in bone, and initiation of catecholamine release from the adrenal medulla and adrenergic synapses. Recent evidence indicates that individuals with essential hypertension have significantly higher plasma catecholamine levels than normotensives.

The present study has examined by epidemiologic and supportive laboratory studies whether or not human mortality and morbidity rates were significantly higher ($P<0.05$)in populations ingesting greater than 1.0 mg/l barium from their drinking water, as compared to populations that ingest very little or no barium from their drinking water. Differences in cardiovascular mortality, blood pressure levels, and the prevalence rates for hypertension, heart disease, stroke and kidney disease were examined.

SECTION 2

CONCLUSIONS

PRIMARY CONCLUSIONS

A retrospective epidemiological analysis for the years 1971-1975 of age-adjusted death rates for all cardiovascular diseases, heart disease, cerebrobascular disease, general arteriosclerosis, hypertension without mention of heart, and other circulatory disease found significantly higher ($P < 0.05$) death rates for "all cardiovascular diseases" and "heart disease" between the high barium (> 2.0 mg/l) and the low barium (≤ 0.2 mg/l) communities. Since there was a greater population change in some of the high barium communities compared to the low barium communities, and no method of controlling for removal of barium by home water softeners, any inferences drawn about this finding must be interpreted with caution.

A morbidity study performed on residents of West Dundee, Illinois, which has a mean barium concentration of 7.3 mg/l in its drinking water, and on those of McHenry, Illinois, which has a mean barium level of 0.1 mg/l in its drinking water, showed some significant differences ($P < 0.05$) between these two communities with respect to mean age and sex-adjusted levels of systolic blood pressures. Although some differences in systolic blood pressure levels were found between the high barium and low barium communities, the results are inconclusive because of inconsistencies in the data. For instance, when the data was adjusted for duration of exposure, a difference in systolic blood pressures was noted for females living in the community for 10 years or less, but not for females residing there for greater than 10 years. Also, male systolic blood pressure were significantly higher in West Dundee when the data was adjusted for duration of exposure, home water softeners and high blood pressure medication. This finding was not found for female systolic blood pressures when adjustment was made for the same factors. No significant differences were observed between these two communities with respect to the prevalence of hypertension, heart disease, stroke, or kidney disease. Further study is needed to resolve the inconclusiveness of the results due to inconsistencies in the data.

SECONDARY CONCLUSIONS

No significant differences ($P > 0.05$) were found for males and females from either community with respect to the prevalence of hypertension, heart disease, stroke or kidney disease and sodium concentration. In addition, sodium concentrations greater than 100 mg/l had no significant effect on male or female blood pressures. As a consequence, home water softeners were found to have no association with cardiovascular disease in this study.

SECTION 3

RECOMMENDATIONS

PRIMARY RECOMMENDATIONS

Any subsequent investigations of the health effects of ingestion of barium from drinking water should not conduct a retrospective epidemiological analysis of death rates because home water softener use cannot be controlled. Since water softeners remove barium from the water, it is practically impossible to relate cardiovascular mortality to high barium concentrations.

An epidemiological study of humans residing in a community for greater than 10 years and exposed to at least 5.0 mg/l barium in their drinking water should be conducted to determine whether or not there are any long term health effects that could not be detected from this study. This study should examine possible physiological and biochemical effects of barium ingestion through the collection of blood and urine samples.

SECONDARY RECOMMENDATION

A chronic animal study designed to examine adverse effects of ingested barium on the cardiovascular system including the production of hypertension and the release of catecholamines should be conducted.

SECTION 4

BACKGROUND INFORMATION

WATER DATA

The IEPA has identified 16 cities and 2 subdivisions, totaling more than 150,000 individuals, that have drinking water sources with barium concentrations above the current Illinois Standard and Federal MCL of 1.0 mg/l (1,2, 3,4) (Table 1). Most of these community water supplies do not employ treatment to reduce the barium concentration in finished water. One community, Crystal Lake, Illinois, softens its water to remove barium but blends this soft, low-barium water with unsoftened water to produce a water that will not be corrosive to interior surfaces of the mains in the distribution system. With this procedure, barium concentration is reduced by approximately 40 percent, resulting in a barium level in the finished water at Crystal Lake that remains above the MCL of 1.0 mg/l (1).

All of the Illinois water supplies with barium exceeding 1.0 mg/l are from deep rock or drift wells found in northern Illinois. These barium concentrations are the results of a naturally occurring geochemical pollutant found almost exclusively in the Cambrian-Ordovician Aquifer in northern Illinois (2). The concentrations of barium reported in Table 1 are results of well samples which were collected at the treatment plant site and do not necessarily represent the levels in drinking water of individual homes, as home water softeners will remove barium. Additionally, home concentrations can differ from that reported at the treatment plant because water systems using multiple wells will often mix water from several wells before distributing it. The range of barium concentrations listed in Table 1 represent concentrations found in individual wells at the treatment plant before mixing.

TOXICITY

Acute human and animal exposures have demonstrated that the single most characteristic action following barium ingestion is an intense stimulation of smooth, striated, and cardiac muscle (5,6,7). Symptoms in humans following acute accidental ingestion include salivation, vomiting, diarrhea, ventricular tachycardia, hypertension, hypokalemia, twitching, flaccid paralysis of skeletal muscle and, if poisoning is severe, respiratory muscle paralysis and ventricular fibrillation which can lead to death. The fatal dose of ingested barium chloride for humans is 0.8-0.9 gm (550-660 mg as barium), while barium carbonate and barium sulfide are also toxic but act more slowly (8). Chronic health effects from exposure to low levels of barium in drinking water have not been extensively studied. A subchronic oral toxicity study of barium

TABLE 1. ELEVATED BARIUM LEVELS IN ILLINOIS DRINKING WATER

County	City or Village	Total (1970) Population	Raw Water *, + Concentration (mg/l)
Bureau	Seaton	251	1.8
Carroll	Shannon	848	2.9-4.7
Cook	Hoffman Estates	22,238	1.6-5.1
DeKalb	Briarwood Subdiv.	NA	1.1
DeKalb	Dekalb	32,949	1.1-1.9
DeKalb	Malta	961	1.5-2.3
DeWitt	Farmer City	2,217	1.2
DuPage	Hanover Park	11,916	1.4-7.0
Kane	Burlington	456	1.8-2.3
Kane	Elgin	55,691	1.7-6.8
Kane	West Dundee	3,295	2.9-10.0
Kane	Elgin State Hospital	NA	2.8
Kendel	Hollis Park Subdiv.	NA	1.1
Knox	Oneida	728	1.25
Lake	Lake Zurich	4,082	1.3-2.7
McHenry	Algonquin	3,515	4.0-8.3
McHenry	Crystal Lake	14,541	2.2-10.0
Rock Island	Croppers	NA	1.4
Stephenson	German Valley	206	4.4-5.6
Winnebago	Rock Cut State Park	NA	2.0
		153,894	

NA - Data not available

* - Sources of drinking water is predominatly from rock wells

+ - Values represented from at least one well supply chloride fed to rats in drinking water (0 to 250 mg/l) revealed no adverse effects in pathology, hematologic and serum parameters, and clinical signs (9). However, a slight decrease in relative weights of adrenal glands of treated animals was observed but may not have been attributable to barium exposure. A chronic study of rats ingesting drinking water containing 5 mg/l of barium acetate reported no adverse health effects. (10).

METABOLISM

Barium, like other alkaline earth metals, is a bone-seeking element (11, 12,13). The human whole body content of barium is approximately 22-24 mg; more than 90 percent is found in the bone (14,15). Barium is believed to be a nonessential human trace element, and little is known about its biochemical functions in bone or soft tissues (15).

Following injection of radioactive isotopes of barium, the barium is rapidly and preferentially transferred from blood plasma to the bone both in rats and humans (11,12,13,16,17). Oral administration of barium chloride in weanling male rats demonstrates that barium is rapidly absorbed from the gastrointestinal tract, and transmitted to various organs within 30 minutes. Peak concentrations of barium following ingestion were found in one half hour for soft tissues and two hours in the skeleton. After two hours' exposure, the greatest total concentration of absorbed barium was found in the skeleton, compared with that in any of the soft tissues (18). There are no reports which have examined differences in absorption of ingested barium salts other than that of barium chloride. The main reason for using barium chloride for metabolic studies is because it is more soluble in water than any of the other barium salts.

Bone deposition sites of barium appear to occur preferentially in the most active areas of bone growth (19), although recent research indicates that the preferential uptake of barium is localized primarily at bone surfaces (20). Other factors important in absorption and deposition include age, with older rats exhibiting a decreased absorption and bone concentration of barium, and dietary starvation, which elicits a three-fold increase in barium absorption (21,22).

Excretion of either injected or ingested barium in both man and animals occurs principally in the feces rather than the urine (11,13,17,18,23). In humans, rapid removal of a single injected dose of barium is indicated because 85 percent is excreted in the first eight days (16,17). An estimate of the biological half-life for barium in the rat is 90 to 120 days (18).

CARDIOVASCULAR EFFECTS

The barium ion has a profound effect on the electrical and mechanical activity of all muscle types, particularly that of cardiac muscle. Dogs given an intravenous injection of less than 0.01 mM barium chloride per kilogram develop arterial hypertension, extrasystoles, and spontaneous skeletal muscle contractions (5,24). If the injection is increased, multiple premature ventricular contractions, blood pressure drop, flaccid paralysis of skeletal and respiratory muscles, and ventricular fibrillation occur, followed by cardiac arrest leading to death.

Barium chloride perfusion of cat and rat ventricular muscle fibers will initiate pacemaker activity which then leads to spontaneous beating (25,26). Additionally, several studies have reported that barium will initiate pacemaker activity in embryonic chick heart cells that had been "quiescent" and, furthermore, that barium will generate deplorization leading to the generation of action potentials (27,28,29).

Human experimental studies relating cardiovascular effects and barium exposure are virtually nonexistant. However, several authors have carefully monitored electrocardiographic changes associated with the routine radiologic use of the barium enema (30,31,32,33,34). These authors have observed that humans over 60 years of age, with or without a history of previous heart disease, appear to be at high risk to developing cardiac arrhythmias following a barium enema. These observations may not necessarily be attributable to the barium ion but could result from such variables as bowel distention, muscle straining, vagal stimulation, anxiety or dehydration.

HORMONAL SYSTEM EFFECTS

Barium possesses chemical and physiological properties which allow it to replace calcium in processes mediated naturally by calcium, particularly pertaining to its participation in the release of the adrenal catecholamine hormones, epinephrine and norepinephrine, and the release of the neurotransmitter substance norepinephrine from adrenergic synapses (35,36,37).

Calcium assumes a specific role in "stimulus-secretion coupling," associated with the adrenal medulla. Acetylcholine interacts with the plasma membrane of the adrenal chromaffin cell, allowing calcium ions to enter the cells, thus stimulating the release of catecholamines. When calcium in the perfusing medium is replaced with barium, the perfused adrenal gland releases norepinephrine, indicating that barium mimics the action of calcium (38,39). However, barium, unlike calcium, will initiate catecholamine release in the absence of acetylcholine.

The presence of extracellular calcium is necessary for the release of norepinephrine from adrenergic synapses following stimulation of the postganglionic nerve fibers. Barium can substitute for calcium in this release process and, in fact, nearly doubles the output of norepinephrine as compared to that released with calcium (40,41,42).

The catecholamines produce numerous effects on the cardiovascular system (7). Epinephrine acts generally as a vasodilator while norepinephrine acts as a strong vasoconstrictor leading to an increase in blood pressure. Each of these catecholamines produces an increase in arrhythmias. Furthermore, recent evidence indicates that individuals with essential hypertension have significantly higher plasma catecholamine levels than normotensives (43,44, 45). Experimental studies have shown that barium stimulates the release of catecholamines while other studies demonstrate that barium elicits an increase in blood pressure. However, there are no published studies which have examined a possible role of barium in the production of hypertension.

EPIDEMIOLOGICAL STUDIES

An epidemiological study of the chronic human health effects associated with the ingestion of barium above 1.0 mg/l has not, until this study, been performed. A mortality study of trace elements in water samples from South Wales has shown that increased barium levels in water are correlated with a decrease in both total and cardiovascular mortality rates for individuals 35-64 years of age (46). However, the average value for barium concentration from these samples was only 0.04 mg/l.

In the United States, analysis of mortality rates and correlations with 35 drinking water constituents from 94 major cities has been completed (47). The mean concentration of barium in these cities was 0.037 mg/l, ranging from 0.0017 to 0.260 mg/l. Significant negative correlations of barium levels with mortality rates from hypertensive heart disease, arteriosclerotic heart disease and cerebral thrombosis were observed. Barium levels ingested from drinking water by the Illinois population studied in this project are two hundredfold greater (Table 1) than that reported in the U.S. study.

BARIUM WATER STANDARD

The present drinking water standard of 1.0 mg/l was developed utilizing an extrapolation from the occupational air standard of 0.5 mg/m^3 (48,49,50). This occupational standard itself is based upon a "suggested" safe level obtained from workers inhaling barium nitrate; and it is not known what degree of safety, if any, this limit incorporates. Furthermore, as there are no studies examining the adverse human health effects associated with drinking water intake, the extrapolation required several assumptions, including an absorption factor of 0.75 for inhalation and 0.90 through the gastrointestinal tract, both of which are undocumented. The absence of definitive water intake studies and the weaknesses inherent in the air standard indicate the need for additional experimentation to determine more accurately a safe water level for barium.

SECTION 5

PROJECT DESIGN AND METHODOLOGY

The project was designed to examine epidemiologically whether or not human mortality and morbidity rates were significantly different in populations ingesting greater than 1.0 mg/l barium in their drinking water, as compared to control populations that ingest very little or no barium from their drinking water. In reviewing the literature, the principle health effects associated with barium relate predominantly to the cardiovascular system.

MORTALITY METHODOLOGY

Mortality rates for cardiovascular diseases, classified by the International Classification of Disease (ICD) (51), were retrospectively determined from Illinois State Death Data for the years 1971-1975. Comparisons of these age-adjusted death rates were made between communities with high barium levels (≥2.0-10 mg/l) and communities with low or no barium (0.0-0.2 mg/l) in their public water supplies. Mortality rates for the communities with high barium levels were also compared with those from the total population of Illinois in 1970.

In choosing the high and low barium communities for comparison, those with more than 2500 residents were selected because population information in the 1970 Census Report (58) by age is not available in communities with less than 2500 residents. In addition, it was not possible to get death rates for the years 1971 and 1972 for a specific community with less than 2500 people because this information was combined with other communities of similar size on the death certificate tapes that were received from the state of Illinois.

Both the high and low barium communities, chosen from the same counties, were matched for similar demographic and socioeconomic status (SES) characteristics (Tables 2 and 3). One notable exception to the similarities between the high barium communities is seen for the city of DeKalb (Table 2). This community has a larger population, a higher percent of Negro and other races, a lower percent of persons under 18 years old, fewer persons per household, and a younger median age than the other high barium communities. It was included in the mortality part of the study because it has a barium concentration in its drinking water supply between > 1.0-2.0 mg/l. Since this concentration of barium falls between the high barium (2.0 mg/l or greater) and the low barium communities (0.2 mg/l or less), a comparison can be made to see whether or not cardiovascular mortality increases in

TABLE 2 GENERAL CHARACTERISTICS OF PERSONS RESIDING IN ILLINOIS COMMUNITIES WITH 2.0 mg/1 BARIUM OR GREATER IN THEIR DRINKING WATER (58)

	Algonquin	Crystal Lake	DeKalb*	Lake Zurich	West Dundee
Population	3,515	14,541	32,949	4,082	3.295
Males	1,715	7,101	15,439	2,046	1,626
Females	1,800	7,440	17,510	2,036	1,669
% Negro and other races	0.5	0.4	2.7	0.8	0.4
% under 18 years old	36.6	40.9	19.4	39.6	33.5
% 65 years old and over	7.0	6.9	5.1	5.4	10.7
Persons/household	3.81	3.50	2.88	3.45	3.11
Households	1,098	4,143	7,675	1,182	1,015
% change in population 1960-70	74.5	74.9	78.2	18.0	30.2
Median school years completed	12.4	12.6	12.7	12.4	12.4
Mean income ($)	13,398	14,652	12,414	14,588	18,583
Income less than poverty level (% of all families)	3.9	3.0	4.8	3.9	3.1
Median age	26.9	25.7	21.8	26.0	27.2

* DeKalb has a barium water level between > 1.0-2.0 mg/1

TABLE 3 GENERAL CHARACTERISTICS OF PERSONS RESIDING IN ILLINOIS COMMUNITIES WITH 0.2 mg/1 BARIUM OR LESS IN THEIR DRINKING WATER (58)

	Antioch	Batavia	Fox Lake	Geneva	Harvard	Marengo	Libertyville
Population	3,189	8,994	4,511	9,115	5,177	4,235	11,684
Males	1,536	4,367	2,213	4,290	2,471	2,072	5,672
Females	1,653	4,627	2,298	4,825	2,706	2,163	6,012
% Negro and other races	0	5.4	0.3	2.3	0.3	0.5	0.4
% under 18 years old	35.7	36.1	31.5	34.9	33.8	34.9	39.3
% 65 years old and over	9.5	9.7	11.6	10.8	12.5	11.5	7.1
Persons/household	3.17	3.22	2.91	3.05	3.07	3.06	3.44
Households	1,005	2,781	1,546	2,855	1,671	1,371	3,371
% change in population 1960-70	40.6	20.0	21.9	19.2	21.9	18.7	36.5
Median school years completed	12.1	12.3	11.5	12.5	12.1	12.2	12.7
Mean Income ($)	14,196	12,635	11,200	15,308	11,676	11,982	18,583
Income less than poverty level (% of all families)	6.2	2.2	6.7	3.2	3.6	4.1	3.1
Median Age	28.3	29.0	31.2	32.2	30.3	29.7	27.2

proportion to the barium concentration. Communities with high rates of population change and/or high industrialization were excluded from the study as much as possible to minimize variations in barium exposure to other confounding environmental pollutants. The 1970 population number and percent change in population between 1960 and 1970, for the high and low barium communities used in the mortality study, are presented in Table 4. It is also noted in Table 4 that three of the selected high barium communities had greater than 74 percent change in population between 1960 and 1970. The selection of these communities could not be avoided because there were no other communities that had high barium and similar demographic and SES characteristics which could have served as a satisfactory replacement. The city of McHenry was not chosen as a low barium community for the mortality part of the study because it was listed in the 1970 Census Report (58) as having a population increase of 103 percent between 1960 and 1970. Although McHenry was not used for the mortality study, it was used for the morbidity study in the project because this population change had no bearing on that part of the study (Table 7, p. 17).

Using the Illinois Death Certificate tapes for the years 1971-1975, the communities in Table 4 were screened for deaths attributable to the cardiovascular diseases listed in Table 5. Deaths by specific causes were counted for specific age groups using standard population information for each age group as obtained from the 1970 Census Report (58) (Table 6). Then a death rate by cause was computed for each age group of a target population. The average annual age-adjusted death rates for a target population were calculated using the following formula:

$$S(i,t) = \frac{D(i,t)}{R(i,t)} \cdot 100{,}000$$

$$A(t) = \sum_{i=1}^{n} \frac{S(i,t) \cdot P(i)}{\sum_{i=1}^{n} P(i)} \cdot 100{,}000$$

where:

$S(i,t)$ = The age-specified death rate in age group i over t years

$A(t)$ = The age-adjusted death rate over t years

$D(i,t)$ = The number dead in age group i over t years

$R(i,t)$ = The number in age group i in the population at risk over t years

$P(i)$ = The number in age group i in the standard population in the base year

t = The number of years observed

i = A particular age group m years wide

n = The number of age groups

TABLE 4 HIGH AND LOW BARIUM COMMUNITIES USED FOR MORTALITY STUDY (58)

High Barium ($\geq$ 2.0 mg/l) Communities

County	Community	1970 Population (Total Population)	% Population Change (1960-1970)
McHenry	Algonquin	3,515	74.5
McHenry	Crystal Lake	14,514	74.9
DeKalb	DeKalb *	32,949	78.2
Lake	Lake Zurich	4,082	18.0
Kane	West Dundee	3,295	30.2
		(58,382)	

* DeKalb has a barium water level between > 1.0-2.0 mg/l

Low Barium ($\leq$ 0.2 mg/l) Communities

County	Community	1970 Population (Total Population)	% Population Change (1960-1970)
Lake	Antioch	3,189	40.6
Kane	Batavia	8,994	20.0
Lake	Fox Lake	4,511	21.9
Kane	Geneva	9,115	19.2
McHenry	Harvard	5,177	21.9
Lake	Libertyville	11,684	36.5
McHenry	Marengo	4,235	18.7
		(46,905)	

TABLE 5 EIGHTH REVISION INTERNATIONAL CLASSIFICATION OF DISEASES (ICD) (51)

	ICD Code Number
All Cardiovascular Disease	All ICD Code #'s listed in a - e
a. Heart Disease	All ICD Code #'s listed in (1) and (2)
1. Arteriosclerosis	393-399, 410, 412
2. Other	402, 404, 411, 413, 414, 420-423, 425-429
b. Cerebrovascular Disease	430-438
c. Other Circulatory Diseases	390-392, 424, 441-458
d. General Arteriosclerosis	440
e. Hypertension without Mention of Heart	400, 401, 403
All Causes	All ICD Code #'s

TABLE 6 POPULATION INFORMATION BY AGE GROUP FOR HIGH BARIUM COMMUNITIES, CITY OF DEKALB, LOW BARIUM COMMUNITIES, AND STATE OF ILLINOIS

Age Group (Years)	1970 Census Population (58)			
	High Barium Communities	City of DeKalb*	Low Barium Communities	State of Illinois
0-4	2,387	1,754	3,953	936,950
5-14	5,909	3,570	9,830	2,233,280
15-24	3,933	16,776	7,465	1,854,706
25-44	6,749	5,372	10,906	2,652,796
44-64	4,626	3,785	10,106	2,342,590
65+	1,829	1,692	4,645	1,093,654
Total Population	25,433	32,949	46,905	11,113,976

* The city of DeKalb was treated separately from the other high barium communities because it has a barium level between 1.0 and 2.0 mg/l, while all the other high barium communities had barium levels greater than 2.0 mg/l. Also, DeKalb's demographic and SES characteristics were not quite as similar as those of the other high barium communities (Table 2).

The Illinois death certificate information was obtained from the Illinois Department of Public Health under the conditions that these tapes be used in the strictest confidence, no personal identification would be used, and that only people associated directly with the study were to have access to the tapes. Mortality rates for the total Illinois population were obtained from the Annual Statistics Reports of Illinois (56). The mortality data was analyzed on an IBM system/370 computer (Model 158).

MORBIDITY METHODOLOGY

A morbidity study was performed in two northeastern Illinois communities with different concentrations of barium in their drinking water to examine differences in blood pressure levels as well as prevalence rates for hypertension, cardiovascular, cerebrovascular and renal disease. West Dundee was selected as the high barium community because it has a mean concentration of barium in its public water supply of 7.3 mg/l (57), which is more than seven times the Federal MCL. Furthermore, West Dundee was chosen because it supplies drinking water to the community from one well with a back-up well for emergency use only, so that mixing of various barium concentrations from multiple wells was not a confounding factor. The routinely used well is drilled to a depth of 365.8 meters and has supplied West Dundee with its water since 1959. Prior to 1959, West Dundee received water from an East Dundee spring that did not have any barium.

A control community, McHenry, was matched with West Dundee for as many demographic and SES characteristics as possible (Tables 7 and 8) (58), except that the mean barium concentration in McHenry public water was 0.1 mg/l (57). McHenry has received its public water from four shallow wells. The first well was drilled in the early 1930's at a depth of 36.6 meters. A second well was drilled in 1961, at 17.4 meters. A third well was drilled in 1967, at 54.8 meters; and, in 1976, a fourth well was drilled at 39.6 meters.

After West Dundee and McHenry were selected, it was decided that a minimum of 1000 people 18 years of age and older in each of the communities would be randomly selected by blocks. Adults 18 years of age and older were chosen for this study because it is well known that cardiovascular diseases are more prevalent in adults than children. In addition, the inclusion of children in the study would have added more age groupings with some age groups having a short exposure period to the barium. As a consequence, it was felt that if only adults were used, a stronger more beneficial study could be designed.

A sample size of 1000 people from each community was chosen to be large enough so that if the prevalences of hypertension were 10 per 100 persons or higher in the high barium community, and 5 per 100 persons or lower in the low barium community, there would be a 90 percent probability of detecting these differences statistically by means of hypothesis tests using the 5 percent level of significance as the criterion. The methodology used in the sample size calculations is similar to that discussed in the textbook by Fleiss (59). Once a block was selected, all households in the entire block were surveyed.

TABLE 7 GENERAL CHARACTERISTICS OF PERSONS RESIDING IN WEST DUNDEE OR McHENRY, ILLINOIS (58)

	West Dundee	McHenry
Population	3,295	6,772
Males	1,626	3,268
Females	1,669	3,504
% Negro & other races	0.4	0.2
% under 18 years old	33.5	35.2
% 65 years old and over	10.7	12.1
Persons/household	3.11	3.16
Households	1,015	2,138
% change pop. 1960-1970	+30.2	+103.0*
Median school years completed	12.4	12.1
Mean income	13,795	12,789
Income less than poverty level (% of all families)	3.0	3.2

* The reason for a high percent change in population is that a large area with approximately 2600 people was annexed to McHenry in 1967. The annexed area was not connected to the public water supply and was not included in this study. Therefore, the actual change in the McHenry study population from 1960-1970 was approximately 20 percent greater in 1970 than it was in 1960.

TABLE 8 OCCUPATIONS OF PERSONS,16 YEARS OLD AND OVER, RESIDING IN WEST DUNDEE OR McHENRY,ILLINOIS (58)

Occupation (16 years old and over)	West Dundee (%)	McHenry (%)
Professional, technical,and kindred workers	19.6	15.6
Managers and administrators	9.4	8.4
Sales workers	11.5	9.3
Clerical and kindred workers	15.5	17.1
Craftsmen, foreman, and kindred workers	16.3	18.8
Operatives, except transport	9.6	12.3
Transport equipment operatives	1.3	4.8
Laborers, except farm	1.4	2.8
Service workers	7.6	10.4
Private Household workers	0.8	0.6
Farmers and farm managers	0.3	--
Farm laborers and farm foremen	6.5	--
Total	99.8	100.1

Permission to conduct this survey was obtained from the Village Board of West Dundee and the City Council of McHenry. Publicity for the study was obtained primarily through news releases to the local newspapers in the communities and through the local radio stations.

Four survey workers were hired and trained to take blood pressures, pulse readings, skinfold readings, to administer a health questionnaire and to collect a tap water sample from each household. They were trained to take blood pressure and pulse and skinfold readings by a physician from our research team. Survey Research Laboratory (SRL), University of Illinois Chicago Circle Campus, through the use of a training manual, explained the proper procedure for adminstration of the health questionnaire. The survey workers collected the above data over a twelve month period with each worker alternating back and forth between both communities.

Blood pressures were taken with an electronic blood pressure apparatus, Sphygmostat Model B-250. This battery operated electronic apparatus has been designed specifically to overcome the disadvantages of hearing the Korotkow sounds with a stethoscope. A special microphone in the cuff detects the Korotkow sounds as the cuff is deflated; these signals are processed electronically, such that the pressures on the manometer correspond to the first and last flashed of a red light on the instrument panel representing systolic and diastolic pressures respectively (60). These instruments were checked for accuracy once a month during the twelve months of field work against a sphygmomanmeter. Once trained, the survey workers took three blood pressure readings of each male and female household member 18 years of age and older. These blood pressure readings were taken to estimate the prevalence of hypertension in the two communities. They were taken at the beginning, middle and end of the period during which the questionnaire was administered. All blood pressures were taken with the individual seated and with his or her arm resting on a table. If a blood pressure above normal was recorded by a survey worker, the individual was advised to see a physician.

Pulse and skinfold readings were obtained following the administration of the health questionnaire. Each volunteer had his/her pulse taken for 30 seconds on the wrist. Two skinfold readings were taken in the area of the triceps using a Lang Caliper. If the skinfold reading is to have any meaning, it is important that the location of measurement be precise. Therefore, the triceps' skinfold measurement was made at the back of the upper arm, at the level midway between the tip of the acromial process of the scapula and the tip of the elbow with the arm pendant (61). The significance of the skinfold test is that it is a direct, simple and accurate method for estimating the leanness-fatness of an individual.

The health survey questionnaire used in this study was developed in consultation with Survey Research Laboratory (SRL), University of Illinois Chicago Circle Campus and reviewed by the U.S. Department of Health Education, and Welfare, Center for Disease Control (Appendix A). The questionnaire was developed with the objective of obtaining morbidity information related to the history of stroke and myocardial infarction, and the prevalance of hypertension, peripheral vascular and renal diseases. An interviewer training manual was developed by SRL for use by the survey workers, a pretest of five households by each worker was conducted, and a follow-up meeting with SRL took place upon completion of the pretest to resolve problems with the questionnaire and/or interview process. In addition, a meeting was held once a month with the survey workers to resolve problems and to check the calibration of the equipment.

A final part of the household morbidity study was for the survey worker to collect one water sample from each participating household. The procedure for collection of the sample was as follows: "Use the cold water tap in the kitchen. Turn on the cold water tap and let it run for 30 seconds. Fill the quart plastic container to the top and cap it tightly." Inquiry was made in the health questionnaire as to whether or not this cold water tap was connected to a home water softener. Since there is a concern about the relationship of softened water and cardiovascular disease (52, 53, 54, 55), it was important to gather information about home water softeners because of the possible effect these softeners could have in masking any effect barium might have on cardiovascular disease. One of the survey workers collected a water sample on a bimonthly basis from the West Dundee and McHenry water treatment plants. See Section 5, Analytical Procedures, for details of collection and analysis of the water samples.

All survey workers presented themselves at households in the study communities with a University of Illinois identification, a letter signed by the mayor endorsing the study, and newspaper clippings describing the study. All the survey workers selected were females because it was felt that they would be more successful in recruiting housewives alone at home for the study. Finally, ten percent of the households that volunteered for the study were called on the telephone to verify questionnaire information that had been collected by the survey workers.

The procedure for recruitment of households for this study was for the survey worker to go to a selected household, describe the study, and encourage the household member to participate. If a household member volunteered for the study, he/she was immediately interviewed. Appointments were made for the other household members 18 and older, if they were not home at the time of recruitment. If a household refused to participate in the study when contacted by the survey worker, a personal letter from the project manager of this study was sent to the household describing the study in greater detail, telling of the importance for their participation in the study, and mentioning that they would be contacted via telephone in a few days to see if a convenient time could be found for an interview (Appendix B).

The collected data was coded, key punched and verified onto computer tapes by SRL. After the data was transferred to computer tapes, a program was written to SRL to "clean" the tapes before analysis. Analysis of the data was performed using an IBM 370/158 computer and the Statistical Package for Social Sciences (62).

ANALYTICAL PROCEDURES

Collection and Preservation of Samples

Household and treatment plant water samples were collected in 946 ml (32) oz.) polyethylene containers containing a preservative of 20 ml of 1:1 (one part HNO_3 to one part H_2O) in each container. Ten percent of these water samples were collected in a 1,892 ml (half gallon) container and split into two 946 ml (32 oz.) containers for quality control.

Analysis of Water Samples

The Illinois Environmental Protection Agency (IEPA) used a Perkin-Elmer Model 403 and Jarrell-Ash Model 810 atomic absorption units to analyze all the collected water samples for calcium, magnesium, sodium, barium, cadmium, chromium (total), copper, lead, nickel, zinc, and strontium. Mercury was analyzed using an Air Pollution Technology Corporation Mercometer Model 2006-1. The IEPA used their standard procedures for all atomic absorption analysis (63).

Ten percent of the split samples were analyzed by the U.S. EPA, Region V, Central Regional Laboratory (CRL) for quality assurance purposes. The U.S. EPA analyzed all of the above elements except mercury, using an inductively coupled argon plasma system (64). Mercury was run by an alternate test procedure (65). Analytical results between the two laboratories were considered in control for concentrations significantly above the detection limits if the agreement between laboratories was better than ten percent.

STATISTICAL PROCEDURES

Since the a priori feeling was that a high barium community could have excess morbidity and mortality, all statistical tests of hypotheses were one-sided in that the null hypothesis would be rejected if the rates were sufficiently higher in a barium community, but not if they were higher in a low barium community. This use of one-sided tests increases the power of the test against the alternatives that are of interest.

Since the data were collected from a complex cluster sample in which blocks were primary sampling units, households were listing units and more than one person per household could appear in the sample, use of "classical" statistical techniques such as analysis of variance and regression would be inappropriate. Instead, use was made of the signed rank test, which is a nonparametric test having high efficiency and which is relatively insensitive to violations of assumptions of independence and simple random sampling. In using this test, each age-sex grouping was considered as a statistical sample of size one, and the signed rank statistic was computed over all age-sex groups. Examination of statistical difference in age-sex adjusted total population means was performed using a weighted Z test.

The Mantel-Haenszel Test (59) was used to examine whether or not there was a relationship between age-adjusted mortality from cardiovascular diseases in communities with barium levels exceeding the Federal MCL as compared to communities with little or no barium in their drinking water. This statistical test was also used to examine whether or not there was a relationship between heart disease, hypertension, stroke or kidney disease and softened water. These morbidity analyses were adjusted for sex, age and community.

SECTION 6

RESULTS AND DISCUSSION

MORTALITY STUDY

In Table 9, age and sex-adjusted death rates for cardiovascular diseases in communities with barium levels 2.0 mg/l or greater are compared to age and sex-adjusted death rates for cardiovascular diseases in communities with barium levels 0.2 mg/l or less for the years 1971-1975. For the most part, it is noted that these death rates are higher in the high barium communities when compared to the death rates in the low barium communities. Of those death rates which were higher in the high barium communities, a significant difference ($P < 0.05$), using the Mantel-Haenszel Test (59), was found for male and female deaths combined for "all cardiovascular diseases," "heart disease (arteriosclerosis)" and "all causes." When males and females were analyzed separately, a significant difference ($P < 0.05$) was found only for male deaths from "all cardiovascular diseases," and for female deaths from "all causes." The 65+ age group accounted for the largest difference between observed and expected deaths. Although "hypertension without mention of heart" had the largest death ratio of the high barium to low barium communities, it was not significant possibly because the small number of recorded deaths make the resulting estimates too unstable for any conclusions or inferences to be drawn.

In Table 10, age-adjusted death rates for cardiovascular diseases in the City of DeKalb with a barium level greater than 1.0 mg/l and less than 2.0 mg/l are compared to age-adjusted death rates for cardiovascular diseases in communities with barium levels 0.2 mg/l or less for the years 1971-1975. Generally, the death rates in the City of DeKalb are lower than those in the low barium communities. Two exceptions are the death rates for "heart disease (other)" and "other circulatory disease" which are higher in the City of DeKalb. Of those disease categories, only "other circulatory disease" is significantly different ($P < 0.05$) for males and females combined between the City of DeKalb and the low barium communities. When male and female deaths from "other circulatory disease" were analyzed separately, a significant difference ($P < 0.05$) was found for the females. Once again the 65+ age group had the largest difference between observed and expected deaths.

Age-adjusted death rates for cardiovascular diseases in communities with barium levels 2.0 mg/l or greater, greater than 1.0 mg/l but less than 2.0 mg/l, and 0.2 mg/l or less are compared to the average death rates between 1970 and 1975 for cardiovascular diseases for the total Illinois population (Table 11). Generally, both the high and low barium communities had higher

TABLE 9 COMPARISON OF AGE AND SEX-ADJUSTED DEATH RATES PER 100,000 PERSONS FOR CARDIOVASCULAR DISEASES IN COMMUNITIES WITH BARIUM LEVELS 2.0 mg/1 OR GREATER AGAINST THOSE IN COMMUNITIES WITH BARIUM LEVELS 0.2 mg/1 OR LESS: 1971-75

Category	High Barium Communities			Low Barium Communities			Death Ratio (A)/(B)
	# of Deaths		Death Rates (A)	# of Deaths		Death Rates (B)	
	Males	Females		Males	Females		
All Cardiovascular Disease	335	290	651.1	720	634	573.4	1.136[†]
a. Heart Disease	269	206	493.9	569	451	432.0	1.143[†]
1. Arteriosclerosis	259	199	476.8	543	434	413.8	1.152[†]
2. Other	10	7	17.1	26	17	18.2	0.940
b. Cerebrovascular Disease	45	62	113.1	91	137	96.5	1.172
c. General Arteriosclerosis	8	8	16.7	23	20	18.2	0.918
d. Hypertension without Mention of Heart	2	7	9.4	6	6	5.1	1.843
e. Other Circulatory Disease	11	7	18.0	31	20	21.6	0.833
All Causes	638	520	1148.2	1335	1109	1036.8	1.107[†]
Population (1970)	12,488	12,945		22,621	24,284		
Total Person Years	62,440	64,725		113,105	121,420		

[†] $p < 0.05$ (for males and females combined using the Mantel-Haenszel Test (59))

TABLE 10 COMPARISON OF AGE AND SEX-ADJUSTED DEATH RATES PER 100,000 PERSONS FOR CARDIOVASCULAR DISEASES IN THE CITY OF DeKALB WITH A BARIUM LEVEL GREATER THAN 1.0 mg/l AND LESS THAN 2.0 mg/l AGAINST THOSE IN COMMUNITIES WITH BARIUM LEVELS 0.2 mg/l OR LESS: 1971-75

Category	City of DeKalb			Low Barium Communities			Death Ratio
	# of Deaths		Death Rates	# of Deaths		Death Rates	(A)/(B)
	Males	Females	(A)	Males	Females	(B)	
All Cardiovascular Diseases	213	195	471.1	720	634	573.4	0.822
a. Heart Disease	163	120	327.5	569	451	432.0	0.758
1. Arteriosclerosis	151	109	302.1	543	434	413.8	0.730
2. Other	12	11	25.3	26	17	18.2	1.390
b. Cerebrovascular Disease	31	50	92.8	91	137	96.5	0.962
c. General Arteriosclerosis	3	6	10.4	23	20	18.2	0.571
d. Hypertension without Mention of Heart	0	2	2.3	6	6	5.1	0.451
e. Other Circulatory Disease	16	17	38.2	31	20	21.6	1.769†
All Causes	393	370	852.9	1335	1109	1036.8	0.823
Population (1970)	15,439	17,510		22,621	24,284		
Total Person Years	77,195	87,550		113,105	121,420		

† $p < 0.05$ (for males and females combined using the Mantel-Haenszel Test (59))

TABLE 11 COMPARISON OF AGE AND SEX-ADJUSTED DEATH RATES PER 100,000 PERSONS FOR CARDIOVASCULAR DISEASES IN COMMUNITIES WITH BARIUM LEVELS > 2.0 mg/1, > 1.0 mg/1 AND < 2.0 mg/1, AND 0.2 mg/1 OR LESS AGAINST THE AVERAGE DEATH RATES BETWEEN 1970 and 1975 FOR THE ILLINOIS POPULATION

Category	**High Barium** Communities (> 2.0 mg/1) (A)		City of DeKalb Barium (<2.0 mg/1) (B)		Low Barium Communities (< 0.2 mg/1) (C)		Illinois Average Death Rates Between 1970 and 1975 (D)
	(A) Death Rates	Death Ratio (A/D)	Death Rates	Death Ratio (B/D)	Death Rates	Death Ratio (C/D)	
All Cardiovascular Diseases	651.1	1.223	471.1	0.885	573.4	1.077	532.4
a. Heart Disease	493.9	1.228	327.5	0.814	432.0	1.074	402.3
1. Arteriosclerosis	476.8	1.316	302.1	0.834	413.8	1.142	362.3
2. Other	17.1	0.428	25.3	0.633	18.2	0.455	40.0
b. Cerebrovascular Disease	113.1	1.223	92.8	1.003	96.5	1.043	92.5
c. General Arterio-sclerosis	16.7	1.168	10.4	0.727	18.2	1.273	14.3
d. Hypertension without Mention of Heart	9.4	1.808	2.3	0.442	5.1	0.981	5.2
e. Other Circulatory Disease	18.0	0.989	38.2	2.099	21.6	1.187	18.2
All Causes	1148.2	1.210	852.9	0.899	1036.8	1.093	948.9
Population (1970)	25,433		32,040		46,905		11,113,976
Total Person Years	127,165		164,745		134,525		55,569,880

death rates for cardiovascular diseases than the state of Illinois, while the City of DeKalb had lower death rates for these diseases when compared to the state average. No statistical tests were run on the above comparisons because differences in such regional factors as SES and demographic characteristics, and urban/rural residencies for the state of Illinois were not controllable in this part of the study. As a consequence, no conclusions can be drawn between difference in death rates in high and low barium communities when compared to the state of Illinois. The average death rates between 1970 and 1975 were used for the state of Illinois because deaths from cardiovascular diseases declined between 1970 (58) and 1975(56) (Table 12).

TABLE 12 DEATH RATES PER 100,000 PERSONS FOR CARDIOVASCULAR DISEASES IN THE STATE OF ILLINOIS

Category	Death Rates in 1970(58)	Death Rates in 1975(56)	Average Death Rates Between 1970 and 1975
All Cardiovascular Diseases	568.1	496.6	532.4
a. Heart Disease	429.1	375.5	402.3
1. Arteriosclerosis	385.6	339.0	362.3
2. Other	43.5	36.5	40.0
b. Cerebrovascular Disease	98.7	86.2	92.5
c. General Arteriosclerosis	16.2	12.3	14.3
d. Hypertension Without Mention of Heart	5.7	4.6	5.2
e. Other Circulatory Disease	18.4	18.0	18.2
All Causes	994.0	903.8	948.9

See Appendix C for the 1970 Standard Illinois Population broken down by age and sex, the number of person years broken down by age and sex which were used to calculate death rates, and the age-sex specific death rates in Illinois which were used for the Mantel-Haenszel Analyses (59). Appendix D discusses a generalized solution for the Mantel Haenzel Test (59) with an illustrative example from this study.

In summary, Illinois Death Certificates tapes were analyzed for a period of five years to eliminate yearly fluctuations in death rates. Although death rates were age-adjusted and as many demographic and socioeconomic status (SES) characteristics were controlled as possible, additional factors associated with death, other than barium, are of concern in drawing inferences about differences in death rates between high and low barium communities. For example, this retrospective mortality study was not able to control for home water softeners; and as mentioned previously, there appears to be a relationship between softened water and cardiovascular diseases (52, 53

54, 55). Another factor was the population change between 1960 and 1970 in the high and low barium communities (Table 4). Some communities in the high barium group had a considerable increase of population, while all communities in the low barium group had a more stable population. Therefore, it is possible that the death rates in the high barium group for the years 1971-1975, which are based on the 1970 census population, could be higher than the true death rates based on real population figures for the years 1971-1975. These death rates were not available for this study. Therefore, the difference in the death rates between the high and low barium groups could be partly attributed to the difference in population change between these groups. Also, duration of exposure to the barium is certainly a factor to be considered, if cardiovascular deaths are to be associated with barium ingestion. Since many of the individuals in the high barium group who died from cardiovascular disease were exposed to barium for a relatively short period of time, death from cardiovascular disease in these people probably was not related to barium ingestion. In addition, of the six age groups observed for each cardiovascular disease, only the 65+ age group consistently showed excess deaths in the high barium communities. Since there were many uncontrollable factors that could have a decided impact on the results in the mortality study, any inferences drawn about differences in death rates between high and low barium communities must be interpreted with caution.

MORBIDITY STUDY

Characteristics Of Populations Studied

Several characteristics of the 1175 individuals from West Dundee and the 1203 individuals from McHenry, Illinois, who participated in the morbidity study, are given as follows (Tables 13-14): (a) 506 males and 669 females 18 years old and over from West Dundee, and 532 males and 671 females 18 years old and over from McHenry participated in the study. The mean age in years of the males and females in West Dundee was 42.6 and 43.3 respectively, while the mean age in years for the males and females in McHenry was 51.2 and 51.3 respectively. (b) The mean residence time for both males and females in West Dundee and McHenry was 14.0 and 15.1 years respectively. Males and females in West Dundee 65+ years old had a residence time more than twice that of the same age males and females in McHenry, while the males and females between 18-44 years old had a residence time in West Dundee about one-half as long as those of the same age in McHenry. (c) 82.7 percent of the persons from West Dundee and 76.7 percent from McHenry had completed high school. (d) There is a greater percent of full-time employed persons in West Dundee than McHenry (53.2% vs. 38.6%); and West Dundee had fewer people retired or disabled compared with McHenry (12.0% vs. 23.8%). (e) Approximately one-third of the people 18 years old and over presently smoke in both West Dundee and McHenry.

In summary, the characteristics of the populations studied are quite similar. One major difference is that McHenry's population, with more people retired or disabled, has a mean age 8.3 years older than that of West Dundee's population. However, data were analyzed using age-specific means and total population means which were age-adjusted to the total sample size by the direct method of adjustment. This age adjustment allowed for

TABLE 13 AGES AND RESIDENCE TIMES OF WHITE PERSONS 18 YEARS OLD AND OVER RESIDING IN WEST DUNDEE AND McHENRY, ILLINOIS, 1976-77

Parameter Years	West Dundee			McHenry		
	Population Sampled	Mean	STANDARD Deviation	POPULATION Sampled	Mean	STANDARD Deviation
Age						
Males & Females	1175	43.0	17.6	1203	51.3	18.2
a. Males	506	42.6	16.9	532	51.2	18.6
1. 18-44	291	30.3	7.4	205	30.9	7.7
2. 45-64	158	53.8	5.8	152	54.9	5.6
3. 65+	57	74.4	6.4	175	71.9	5.2
b. Females	669	43.3	18.1	671	51.3	17.9
1. 18-44	394	30.4	7.6	252	31.4	7.4
2. 45-64	166	53.7	5.4	226	55.8	6.0
3. 65+	109	74.0	6.5	193	72.1	5.7
Residence						
Males & Females	1175	14.0	16.6	1203	15.1	15.3
a. Males	506	13.9	16.2	532	14.7	14.8
1. 18-44	291	7.8	9.4	205	13.0	10.4
2. 45-64	158	18.6	16.5	152	18.8	15.8
3. 65+	57	32.3	23.1	175	13.1	17.5
b. Females	669	14.1	17.0	671	15.5	15.6
1. 18-44	393	7.1	7.6	251	13.1	11.5
2. 45-64	167	18.8	15.9	227	17.9	15.9
3. 65+	109	32.2	25.3	193	15.8	19.1

TABLE 14 CHARACTERISTICS OF WHITE PERSONS 18 YEARS OLD AND OVER RESIDING IN WEST DUNDEE AND McHENRY, ILLINOIS, 1976-77

Parameter	West Dundee Relative Frequency(%)*	McHenry Relative Frequency(%)**
Sex		
a. Male	43.0	44.1
b. Female	57.0	55.9
Education		
a. None	0.1	0.0
b. Grade school	7.9	12.4
c. Some high school	9.3	10.9
d. High school	38.8	42.0
e. Some college	25.1	20.0
f. College Graduate or more	18.8	14.7
Work Status		
a. Full-time	53.2	38.6
b. Part-time	11.2	10.1
c. Housewife	19.8	24.0
d. Student	1.0	1.2
e. Unemployed	2.7	2.3
f. Retired or disabled	12.0	23.8
Job Location		
a. West Dundee	17.0	0.2
b. McHenry	0.2	31.0
Presently Smoke	38.9	30.8
a. Less than 1 pack/day	12.3	8.3
b. 1 pack/day	13.0	12.3
c. Greater than 1 pack/day	13.6	10.2

* Population sample = 1175
** Population sample = 1203

meaningful comparisons of total population means from communities with different age distributions.

Health Indices

Several health parameters were analyzed using the Wilcoxon Signed-Rank Test on age-specific means (66) and a weighted Z test on total population means to test for statistical differences between the health of West Dundee residents and McHenry residents. All data are presented as age-specific means with standard deviations. The total population means are age-adjusted. Whenever a significant difference was found, it was for a P value < 0.05 unless stated otherwise.

A. Visits to Physicians, Hospitalization and Inability to Carry Out Activities (Tables 15-17).

The mean number of visits to a doctor's office or clinic during the 12 month period from 1975-76 or 1976-77 was essentially the same for all age groups of residents from West Dundee and McHenry (Table 15). Generally, males in both communities visit a physician an average of twice a year, while females make three visits. It is not known why males in McHenry 18-24 years of age had four visits to a physician, while males in the same age category from West Dundee had only two.

Persons were hospitalized an average of approximately 10 days per year in both West Dundee and McHenry (Table 16). The small sample size, in most of the age groups, can account for the variability in hospital stay for some of the age groups, between sexes in the same community, and/or between communities for the same sex. However, a national health interview survey conducted in 1972 found that an estimated 21.6 million hospitalized people in the U.S. spent an average of 10.0 days in the hospital during a 12 month period preceding the interview (67). This national survey, as well as the West Dundee and McHenry survey (Table 16), pointed out that increasing age resulted in an increasing average number of days in the hospital during the reference period. In addition, it was found that a larger proportion of females were hospitalized compared with males. Pregnancies during the 18-44 age categories accounted primarily for this difference. Of people hospitalized in West Dundee during the reference period, 39% were for surgery, 28% for illness, 21% for pregnancy, 5% for injury, and 7% for other. McHenry had hospitalizations as follows: 31% surgery, 39% illness, 18% pregnancy, 6% injury and 6% other.

The mean number of days that persons from West Dundee and McHenry were unable to work or carry out usual activities during reference period was approximately six to seven days (Table 17). It is not known why the males 65-74 years of age from West Dundee and the males and females 75+ years of age had so few days attributed to illness, disability or injury.

In summary, no significant differences were found for the total population age-adjusted means for males or females between the two communities when visits to physicians, hospitalization and inability to carry out activities were compared. These tables were only constructed to show that

TABLE 15 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS OF VISITS TO A DOCTOR'S OFFICE OR CLINIC DURING THE PAST YEAR FOR WHITE PERSONS 18-75+ YEARS OF AGE: WEST DUNDEE AND McHENRY, ILLINOIS, 1975-76 or 1976-77.

Age (Years)	West Dundee						McHenry					
	Male			Female			Male			Female		
	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation
18-24	77	1.9	4.6	114	3.1	5.0	54	4.1	12.8	53	2.9	5.1
25-34	122	1.2	3.5	147	3.0	4.3	77	1.1	1.7	111	3.2	5.2
35-44	92	1.5	3.3	133	2.0	3.7	74	1.3	2.2	88	2.1	3.1
45-54	89	2.5	10.1	91	3.2	7.1	75	1.3	3.8	90	2.5	3.6
55-64	69	3.6	7.4	75	2.4	3.4	77	3.0	5.6	136	3.3	5.5
65-74	29	1.9	2.2	60	3.4	4.8	128	3.0	4.2	137	4.7	8.8
75+	28	4.1	7.0	49	3.5	5.0	47	3.6	4.9	56	3.0	3.6
Total Pop. *	506	2.2	6.1	669	2.9	4.8	532	2.3	3.9	671	3.1	5.7

* Total population means are age-sex adjusted to the total sample size.

TABLE 16 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS OF DAYS SPENT IN A HOSPITAL DURING THE PAST YEAR FOR WHITE PERSONS 18-75+ YEARS OF AGE: WEST DUNDEE AND McHENRY, ILLINOIS, 1975-76 OR 1976-77

	West Dundee						McHenry					
	Male			Female			Male			Female		
Age (Years)	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation
18-24	10	5.6	4.3	22	4.5	4.0	4	6.0	3.4	7	3.3	1.8
25-34	6	5.3	6.0	33	4.9	4.0	5	4.2	2.2	34	4.8	2.9
35-44	9	8.1	6.4	20	9.2	9.0	4	6.5	1.7	12	14.0	31.9
45-54	10	11.2	13.2	11	10.9	10.8	5	5.4	5.4	12	8.7	6.8
55-64	15	8.2	6.5	12	10.8	5.9	14	9.9	10.8	17	11.5	8.0
65-74	1	30.0	--	12	16.5	13.5	22	13.1	10.3	28	16.3	18.3
75+	8	23.6	20.1	7	12.4	8.9	8	9.9	5.8	9	15.4	13.4
Total Pop.*	59	11.4	11.7	117	9.0	9.0	62	8.9	8.8	119	9.7	15.1

* Total population means are age-sex adjusted to the total sample size.

TABLE 17 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS OF DAYS AWAY FROM WORK OR UNABLE TO CARRY OUT USUAL ACTIVITIES DURING THE PAST YEAR BECAUSE OF AN ILLNESS, DISABILITY, OR INJURY FOR WHITE PERSONS 18-75+ YEARS OF AGE: WEST DUNDEE AND McHENRY, ILLINOIS 1975-76 OR 1976-77

	West Dundee						McHenry					
	Male			Female			Male			Female		
Age (Years)	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation
18-24	77	2.8	5.7	114	5.6	16.9	54	1.5	2.7	53	1.8	3.0
25-34	122	3.2	19.0	147	5.0	20.5	77	2.6	8.8	111	4.0	7.8
35-44	92	3.7	14.5	133	4.3	11.3	74	1.8	4.5	88	10.5	43.9
45-54	89	2.9	11.0	91	9.5	36.3	75	3.1	9.2	90	16.2	59.1
55-64	69	17.1	55.8	75	7.4	25.9	77	17.0	71.0	136	3.6	9.4
65-74	29	0.7	3.9	60	10.4	28.3	128	11.1	51.1	137	15.2	56.1
75+	28	19.8	70.4	49	15.0	62.7	47	3.6	17.0	56	4.5	13.0
Total Pop. *	506	6.0	29.4	669	7.5	27.9	532	5.8	38.0	671	8.1	37.7

* Total population means are age-sex adjusted to the total sample size.

the above mentioned health characteristics of the two communities were quite similar.

B. Blood Pressures and Pulse Rates (Tables 18-45)

Since it was found in the literature (Background Section) that barium can have an effect on elevating blood pressure in animals, this study collected blood pressure data from both communities to examine the effects of barium on human blood pressure levels. As expected, highly significant chi square differences were found for blood pressures when age was varied controlling for sex, smoking, years residing in the community, obesity, barium concentration, or sodium concentration. Since it has been shown that blood pressure varies significantly with age (67), the importance of this finding in West Dundee and McHenry verifies the reliability of the collected data.

In Table 18 and Figures 1 and 2, systolic and diastolic blood pressures are presented for persons in West Dundee and McHenry by age and sex. When the data from Table 18 were compared to a blood pressure averages for the U.S. population (Table 19) (68), it was noted that the systolic and diastolic blood pressures in both of the above communities were, on the whole, slightly lower than those in the United States. A signed rank test of the age-specific means of West Dundee male and female systolic and diastolic blood pressures, and a weighted Z test of the age-adjusted total population means for these males and females were not significantly different when compared to the mean blood pressures of McHenry males and females.

Since no statistical differences were found for blood pressures between all males and females in West Dundee when compared to the males and females in McHenry (Table 18), it was felt that a difference might be masked by those people: (1) Living in the communities for a relatively short period of time, (2) taking high blood pressure medication, (3) having a home water softener which removes barium, (4) smoking cigarettes, and (5) having obesity problems. As a consequence, the following presentation of the results and discussion section will reflect the above concerns.

First of all, when blood pressures for males and females living in West Dundee greater than 10 years were compared to McHenry males and females for the same two reference periods, no statistical differences were found between the total population means or the age-specific means (Table 20, Figures 3 and 4). However, when systolic and diastolic blood pressures for West Dundee males and females living in the community greater than 10 years were compared to West Dundee males and females living in the community 10 years or less, a significant difference was found for the males (Table 21). When McHenry males and females living in the community either greater than 10 years or 10 years and less were compared similarly, no significant differences were found (Table 22).

When West Dundee and McHenry males and females living 10 years or less in their respective communities were compared for blood pressure differences (Table 23), a significant difference was found for the systolic blood pressures between the West Dundee and McHenry females for both total population means and age-specific means (P values were respectively equal to 0.06 and

TABLE 18 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS (mm. Hg) OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURE AMONG WHITE PERSONS 18-75+ YEARS OF AGE: WEST DUNDEE AND McHENRY, ILLINOIS, 1976-77

Blood Pressure Age (Years)	West Dundee						McHenry					
	Male			Female			Male			Female		
	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation
Systolic												
18-24	77	123.3	13.9	114	104.6	10.2	54	120.2	12.5	53	106.1	10.6
25-34	122	123.9	13.2	147	106.5	12.3	77	122.2	12.6	111	106.4	11.9
35-44	92	123.9	16.7	133	111.6	15.0	74	124.1	15.2	88	111.3	17.0
45-54	89	127.9	16.2	91	121.3	17.5	75	129.7	15.3	90	116.3	18.6
55-64	69	131.3	21.4	75	128.1	21.1	77	135.6	17.8	136	129.5	22.3
65-74	29	139.1	20.1	60	138.1	21.0	128	140.7	21.0	137	136.2	20.4
75+	28	149.8	20.3	49	151.6	23.4	47	144.8	22.0	56	146.1	21.3
Total Pop. *	506	129.7	17.8	669	120.7	21.5	532	129.8	19.2	671	119.6	22.8
Diastolic												
18-24	77	73.9	10.7	114	70.1	7.9	54	71.5	10.9	53	72.9	6.7
25-34	122	76.8	10.7	147	73.4	9.9	77	78.4	10.4	111	74.6	11.0
35-44	92	82.7	10.4	133	77.3	11.5	74	82.6	11.1	88	79.6	11.6
45-54	89	84.0	11.3	91	83.5	11.1	75	85.8	11.4	90	81.5	14.1
55-64	69	82.7	13.1	75	84.4	14.9	77	86.1	12.7	136	87.0	15.1
65-74	29	82.1	13.8	60	85.8	14.5	128	85.8	13.4	137	86.6	14.7
75+	28	80.4	10.1	49	88.0	14.6	47	81.7	12.5	56	83.4	16.5
Total Pop.*	506	80.4	11.8	669	79.7	13.1	532	81.8	12.7	671	80.6	14.4

* Total population means are age-sex adjusted to the total sample size.

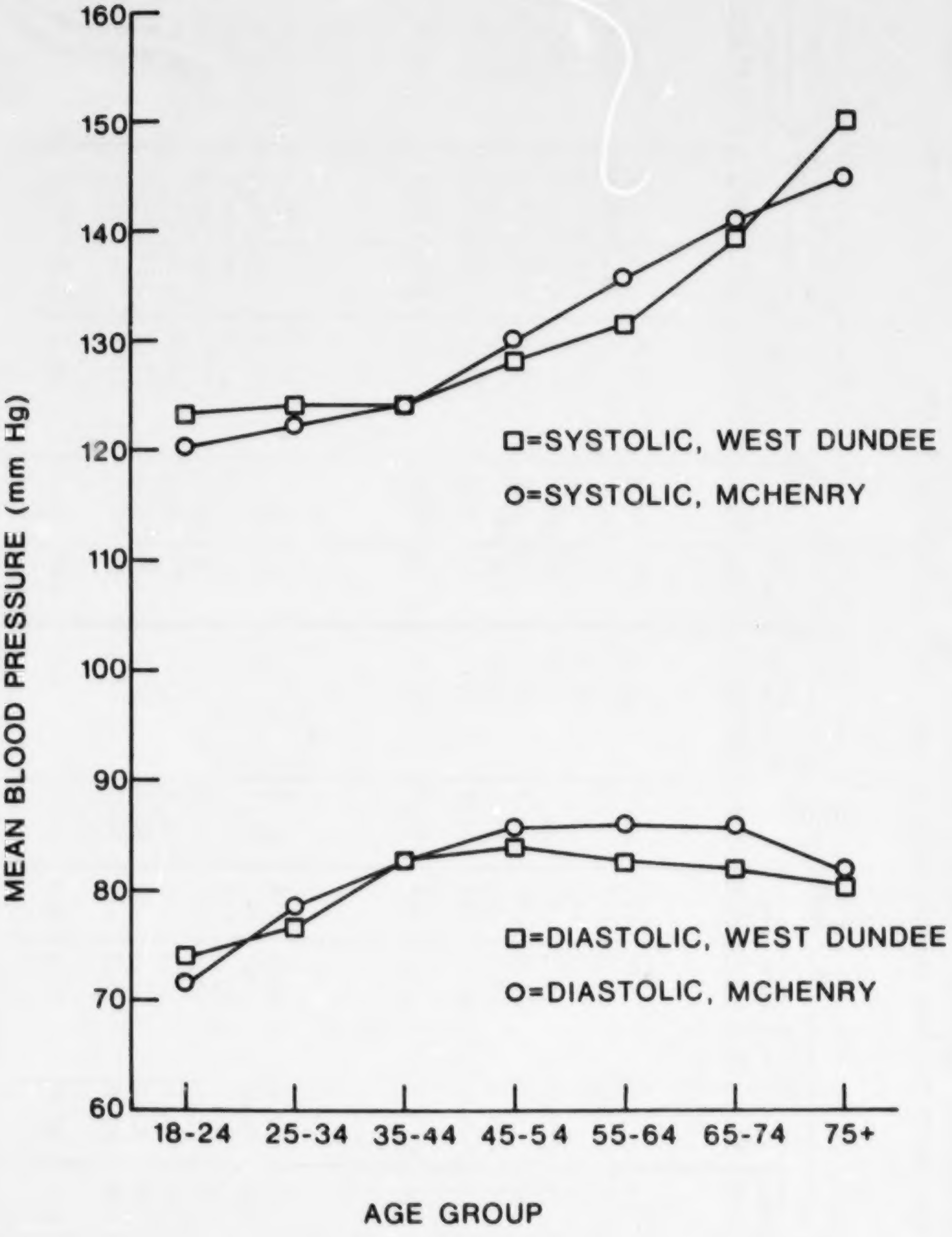

Figure 1. Mean age-specific systolic and diastolic blood pressure among males 18-75+ years of age: West Dundee and McHenry, Illinois, 1976-77.

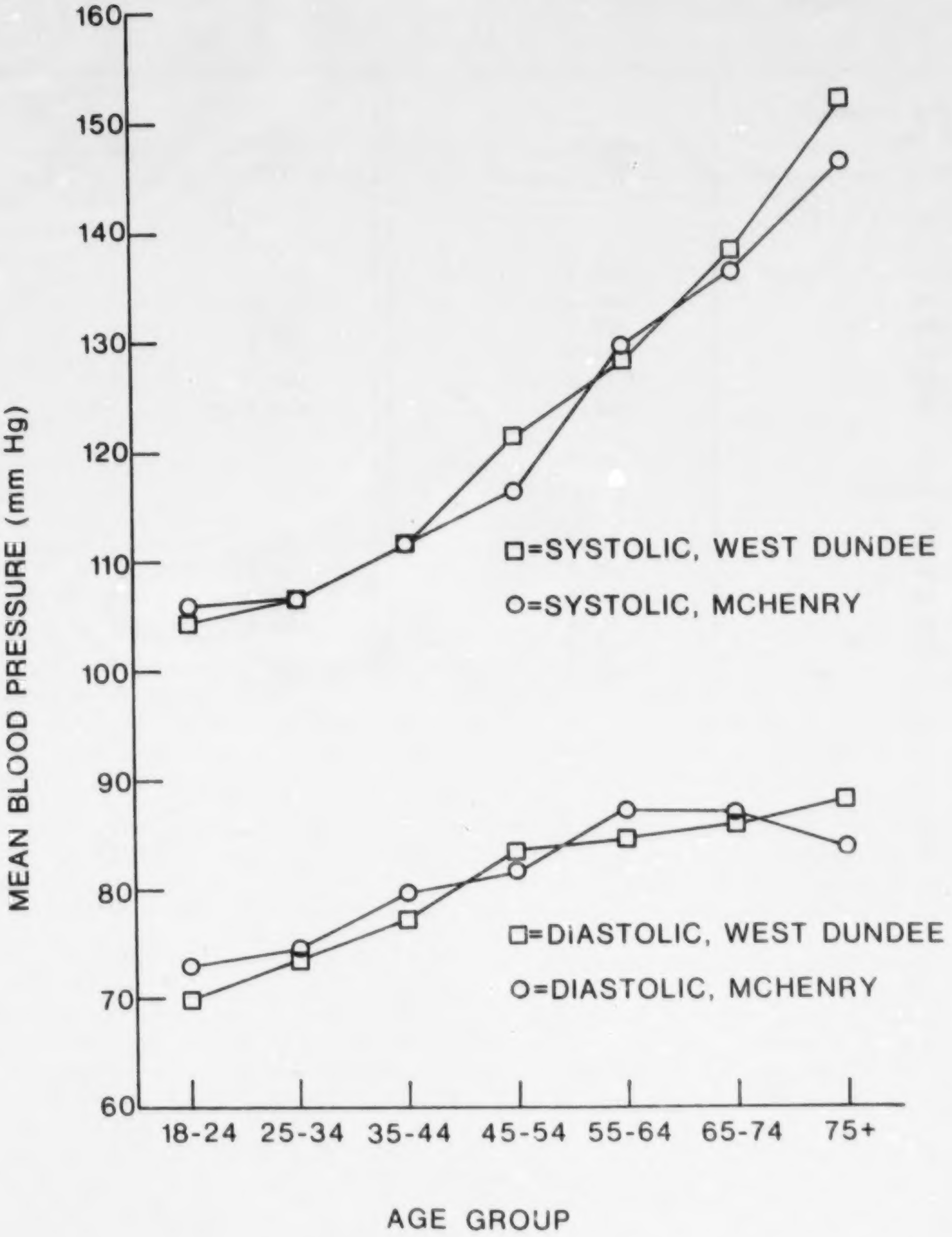

Figure 2. Mean age-specific systolic and diastolic blood pressure among females 18-75+ years of age: West Dundee and McHenry, Illinois, 1976-77.

TABLE 19 AGE-SPECIFIC MEANS (mm. Hg) OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURE AMONG WHITE PERSONS 18-74 YEARS OF AGE: UNITED STATES 1971-74.(68)

Blood Pressure and Age (Years)	Male	Female
	Mean	Mean
Systolic		
18-24	123.7	115.1
25-34	125.2	116.2
35-44	127.0	122.6
45-54	134.7	131.1
55-64	139.6	143.0
65-74	146.0	151.6
Diastolic		
18-24	76.4	71.3
25-34	80.8	74.6
35-44	84.2	79.3
45-54	87.5	82.6
55-64	86.4	86.2
65-74	84.9	85.4

TABLE 20 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS (mm.Hg) OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURE AMONG WHITE PERSONS 18-75+ YEARS OF AGE, WHO HAVE LIVED GREATER THAN 10 YEARS IN: WEST DUNDEE OR McHENRY, ILLINOIS, 1976-77

Blood Pressure	West Dundee						McHenry					
	Male			Female			Male			Female		
Age (Years)	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation
Systolic												
18-24	26	126.0	15.6	27	103.4	10.8	40	122.5	11.2	32	108.6	9.8
25-34	14	125.3	16.4	18	108.2	11.6	26	120.7	13.1	39	105.4	11.3
35-44	31	125.3	20.4	50	111.6	12.6	34	121.8	14.8	50	112.0	17.2
45-54	47	127.9	15.3	48	120.0	16.2	46	131.2	16.6	62	116.9	16.9
55-64	50	134.9	22.7	56	126.6	20.9	43	136.8	19.0	54	124.0	22.3
65-74	23	142.3	20.0	36	135.2	21.9	29	141.3	18.4	34	138.5	22.8
75+	21	150.0	15.5	40	152.8	24.9	14	144.3	21.2	26	147.2	23.2
Total Pop. *	212	131.9	20.1	275	122.6	23.6	232	131.0	18.0	297	121.5	22.1
Diastolic												
18-24	26	75.0	12.1	27	67.7	9.4	40	73.2	10.6	32	73.4	6.7
25-34	14	80.8	11.4	18	74.8	6.0	26	76.3	11.5	39	73.7	11.1
35-44	31	84.5	12.2	50	79.3	11.6	34	83.1	12.7	50	80.2	12.1
45-54	47	84.2	8.8	48	83.0	9.7	46	85.9	12.5	62	81.5	14.0
55-64	50	83.8	13.2	56	84.7	14.6	43	86.4	13.1	54	84.7	15.1
65-74	23	85.0	13.0	36	85.2	13.7	29	84.1	11.6	34	87.1	15.6
75+	21	81.0	10.2	40	90.2	14.8	14	80.5	9.6	26	87.5	19.0
Total Pop. *	212	82.3	11.9	275	81.4	13.7	232	82.2	12.8	297	81.7	14.1

* Total population means are age-sex adjusted to the total sample size.

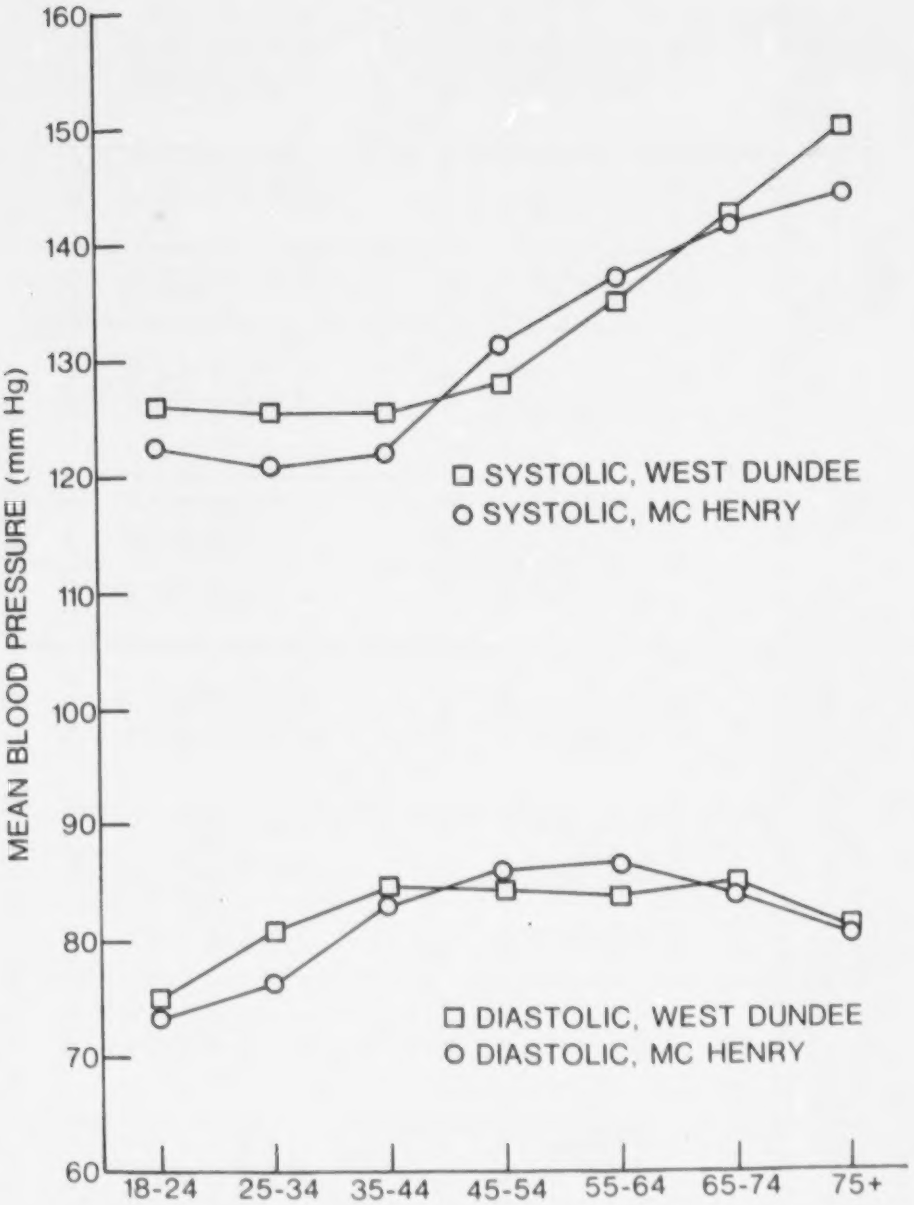

Figure 3. Mean age-specific systolic and diastolic blood pressure among males 18-75+ years of age who have lived greater than 10 years in: West Dundee and McHenry, Illinois, 1976-77.

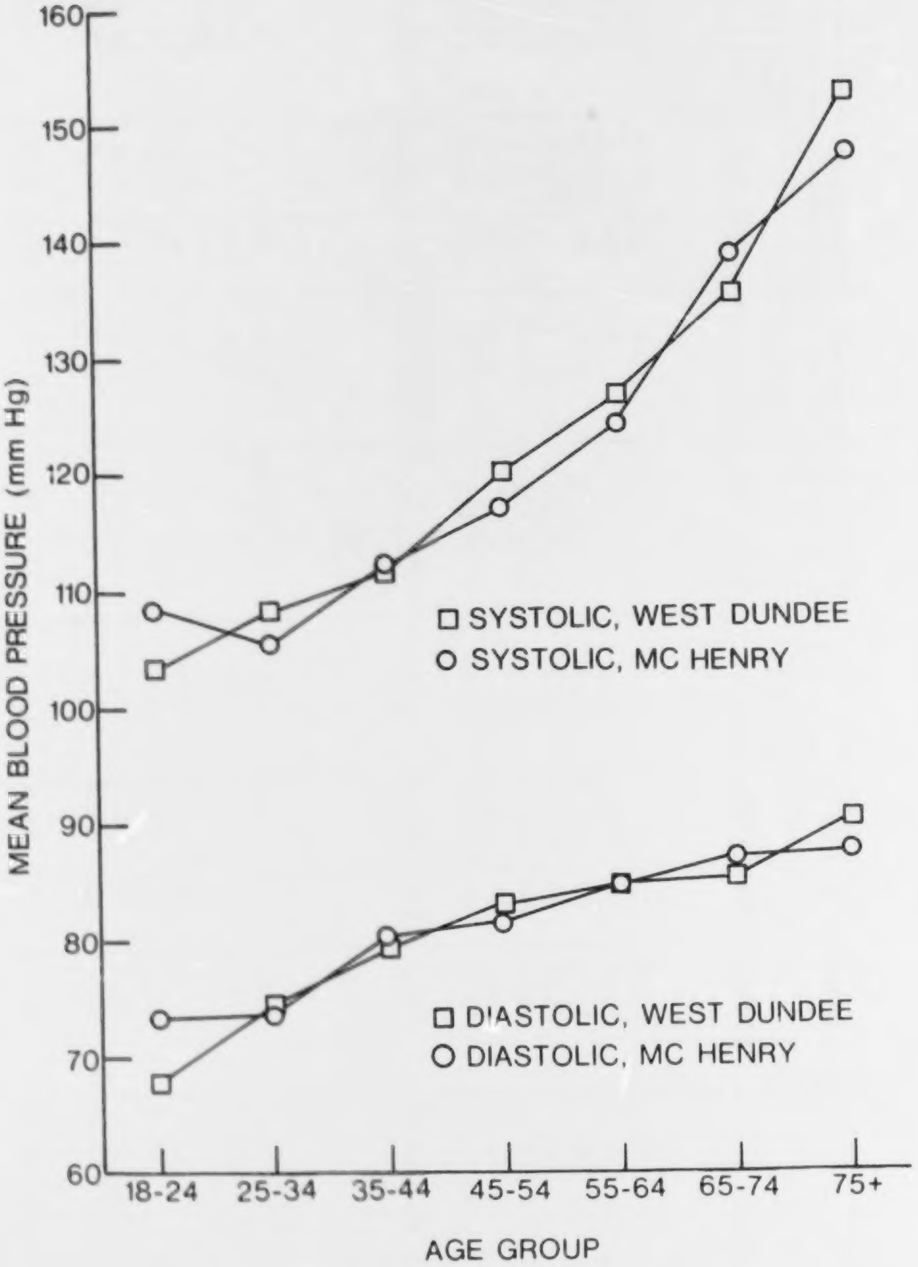

Figure 4. Mean age-specific systolic and diastolic blood pressure among females 18-75+ years of age who have lived greater than 10 years in: West Dundee and McHenry, Illinois, 1976-77.

TABLE 21 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS (mm. Hg) OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURE AMONG PERSONS WHO HAVE LIVED IN WEST DUNDEE FOR GREATER THAN 10 YEARS AND LIVED IN WEST DUNDEE FOR 10 YEARS OR LESS: 1976-77

Blood Pressure	West Dundee (> 10 years)						West Dundee (≤ 10 years)					
	Male			Female			Male			Female		
Age (Years)	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation
Systolic												
18-24	26	126.0	15.6	27	103.4	10.8	51	122.0	12.7	85	105.0	10.0
25-34	14	125.3	16.4	18	108.2	11.6	107	123.8	12.9	128	106.4	12.4
35-44	31	125.3	20.4	50	111.6	12.6	61	123.1	14.5	83	111.7	16.4
45-54	47	127.9	15.3	48	120.0	16.2	42	128.0	17.4	42	122.8	19.0
55-64	50	134.9	22.7	56	126.6	20.9	19	121.9	14.1	19	132.5	21.8
65-74	23	142.3	20.0	36	135.2	21.9	6	127.1	17.0	24	142.5	19.3
75+	21	150.0	15.5	40	152.8	24.9	7	149.2	32.6	9	146.1	14.6
Total Pop.[*]	212	129.5[†]	20.1	275	117.5	23.6	293	125.5[†]	15.2	390	118.6	18.7
Diastolic												
18-24	26	75.0	12.1	27	67.7	9.4	51	73.4	10.1	85	71.0	7.3
25-34	14	80.8	11.4	18	74.8	6.0	107	76.6	10.6	128	73.3	10.4
35-44	31	84.5	12.2	50	79.3	11.6	61	81.9	9.4	83	76.3	11.3
45-54	47	84.2	8.8	48	83.0	9.7	42	83.4	13.6	42	84.3	12.6
55-64	50	83.8	13.2	56	84.7	14.6	19	80.4	12.7	19	83.8	15.6
65-74	23	85.0	13.0	36	85.2	13.7	6	71.2	11.8	24	87.5	15.4
75+	21	81.0	10.2	40	90.2	14.8	7	79.4	10.0	9	78.7	8.8
Total Pop.[*]	212	81.9[†]	11.9	275	78.8	13.7	293	78.6[†]	11.4	390	77.9	12.0

[*] Total population means are age-sex adjusted to the total sample size.

[†] $P < 0.05$ for total population and age-specific means.

TABLE 22 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS (mm.Hg) OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURE AMONG PERSONS WHO HAVE LIVED IN McHENRY FOR GREATER THAN 10 YEARS AND LIVED IN McHENRY FOR 10 YEARS OR LESS: 1976-77

Blood Pressure Age (Years)	McHenry (> 10 years)						McHenry (≤ 10 years)					
	Male			Female			Male			Female		
	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation
Systolic												
18-24	40	122.5	11.2	32	108.6	9.8	14	113.6	14.0	21	102.5	10.9
25-34	26	120.7	13.1	39	105.4	11.3	51	122.9	12.3	71	106.9	12.3
35-44	34	121.8	14.8	50	112.0	17.2	40	126.0	15.4	38	110.3	16.9
45-54	46	131.2	16.6	62	116.9	16.9	28	127.4	12.8	27	115.0	22.2
55-64	43	136.8	19.0	54	124.0	22.3	34	134.1	16.2	81	133.4	21.5
65-74	29	141.3	18.4	34	138.5	22.8	99	140.6	21.9	102	135.7	19.5
75+	14	144.3	21.2	26	147.2	23.2	33	145.0	22.6	30	145.1	19.8
Total Pop.	232	131.0	18.0	297	122.1	22.1	299	130.9	20.0	370	122.5	23.1
Diastolic												
18-24	40	73.2	10.6	32	73.4	6.7	14	67.3	10.9	21	72.2	6.9
25-34	26	76.3	11.5	39	73.7	11.1	51	79.6	9.6	71	75.0	10.9
35-44	34	83.1	12.7	50	80.2	12.1	40	82.6	9.4	38	79.0	10.8
45-54	46	85.9	12.5	62	81.5	14.0	28	85.9	9.2	27	82.0	14.1
55-64	43	86.4	13.1	54	84.7	15.1	34	85.9	12.1	81	88.4	15.1
65-74	29	84.1	11.6	34	87.1	15.6	99	86.5	13.7	102	86.4	14.4
75+	14	80.5	9.6	26	87.5	19.0	33	82.4	13.5	30	80.3	13.2
Total Pop.	232	82.0	12.8	297	81.7	14.1	299	82.5	12.5	370	81.7	14.2

* Total population means are age-sex adjusted to the total sample size.

TABLE 23 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS (mm.Hg) OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURE AMONG WHITE PERSONS 18-75+ YEARS OF AGE, WHO HAVE LIVED 10 YEARS OR LESS IN: WEST DUNDEE OR McHENRY, ILLINOIS, 1976-77

Blood Pressure	West Dundee						McHenry					
	Male			Female			Male			Female		
Age (Years)	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation
Systolic												
18-24	51	122.0	12.7	85	105.0	10.0	14	113.6	14.0	21	102.5	10.9
25-34	107	123.8	12.9	128	106.4	12.4	51	122.9	12.3	71	106.9	12.3
35-44	61	123.1	14.5	83	111.7	16.4	40	126.0	15.4	38	110.3	16.9
45-54	42	128.0	17.4	42	122.8	19.0	28	127.4	12.8	27	115.0	22.2
55-64	19	121.9	14.1	19	132.5	21.8	34	134.1	16.2	81	133.4	21.5
65-74	6	127.1	17.0	24	142.5	19.3	99	140.6	21.9	102	135.7	19.5
75+	7	149.2	32.6	9	146.1	14.6	33	145.0	22.6	30	145.1	19.8
Total Pop. *	293	126.1	15.2	390	120.0†	18.7	299	128.6	20.0	370	117.8†	23.1
Diastolic												
18-24	51	73.4	10.1	85	71.0	7.3	14	67.3	10.9	21	72.2	6.9
25-34	107	76.6	10.6	128	73.3	10.4	51	79.6	9.6	71	75.0	10.9
35-44	61	81.9	9.4	83	76.3	11.3	40	82.3	9.4	38	79.0	10.8
45-54	42	83.4	13.6	42	84.3	12.6	28	85.9	9.2	27	82.0	14.1
55-64	19	80.6	12.7	19	83.8	15.6	34	85.9	12.1	81	88.4	15.1
65-74	6	71.2	11.8	24	87.5	15.4	99	86.5	13.7	102	86.4	14.4
75+	7	79.4	10.0	9	78.7	8.8	33	82.4	13.5	30	80.3	13.2
Total Pop. *	293	77.5	11.4	390	78.5	12.0	299	81.4	12.5	370	79.8	14.2

* Total population means are age-sex adjusted to the total sample size.

† P = 0.06 for total population means and P < 0.05 for age-specific means.

and < 0.05). This finding would be more meaningful if a significant difference in blood pressures would have been found in West Dundee females living in the community greater than 10 years when compared to McHenry females residing in the community for the same time span (Table 20).

Since individuals taking high blood pressure medication could also possibly mask any effect barium might have on blood pressure, West Dundee male and female blood pressures were compared to see if there were any differences in those individuals who were not taking high blood pressure medication, and have lived either greater than 10 years or 10 years and less in their respective communities (Tables 24 and 25). With the exception of systolic blood pressures for females living 10 years and less in their respective communities (Table 25), no significant differences were found in either age-specific or total population mean blood pressures when males and females from West Dundee, not taking blood pressure medication, were compared similarly to males and females in McHenry according to time of residence. In Tables 26 and 27, the same comparisons as in Tables 24 and 25 were made with the exception of removing those individuals diagnosed as having definite hypertension from the data analysis. A significant difference was found between West Dundee and McHenry female systolic total population means whether they lived in the community greater than 10 years or 10 years and less. The mean age-specific female systolic blood pressure were only significantly different when time of residence was 10 years and less (Table 27). Finally, when a comparison of blood pressures of males and females from West Dundee, who do not have definite hypertension nor are currently taking high blood pressure medication, was made against a similar population in McHenry regardless of time in residence, no significant differences were found in either the age-specific or total population means (Table 28). Although no significant differences were noted in Table 28, five of seven West Dundee female age groupings beginning at 35-44 have higher blood pressure than McHenry females in these same age groupings.

Blood pressure comparisons were also made between communities for those individuals with definitive hypertension or currently taking blood pressure medication (Table 29), for those individuals taking blood pressure medication (Table 30), and for those individuals no longer taking blood pressure medication (31). No significant differences were found between West Dundee males and females when the above blood pressure comparisons were made to a similar population of McHenry males and females.

In addition to looking at the blood pressures of those individuals from West Dundee and McHenry with definite hypertension or who are currently taking blood pressure medication (Table 29), the Mantel-Haenszel Test (59) was used to see if there were any statistical difference between West Dundee and McHenry in the numbers of males and females who have this disease or are currently taking medication. No significant differences were found when the number of males and females from each of the seven age groupings from West Dundee were compared similarly to males and females in McHenry (See Appendix D for the statistical computation).

It should be noted in Table 30 that the male age-groups in West Dundee generally have a higher proportion of the total population in each age group

TABLE 24 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS (mm.Hg) OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURE AMONG WHITE PERSONS 18-75+ YEARS OF AGE, WHO ARE NOT TAKING HIGH BLOOD PRESSURE MEDICATION AND HAVE LIVED GREATER THAN 10 YEARS IN: WEST DUNDEE OR McHENRY, ILLINOIS, 1976-77

Blood Pressure	West Dundee						McHenry					
	Male			Female			Male			Female		
Age (Years)	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation
Systolic												
18-24	25	126.4	16.0	27	103.4	10.8	40	122.5	11.2	32	108.6	9.8
25-34	14	125.3	16.4	18	108.2	11.6	26	120.7	13.1	39	105.4	11.3
35-44	27	122.0	14.4	49	111.4	12.6	31	119.1	12.2	49	111.8	17.3
45-54	37	127.5	17.1	42	118.5	15.5	40	130.2	16.1	56	115.9	16.4
55-64	37	133.6	24.0	39	122.1	18.1	38	135.9	19.7	43	120.9	20.2
65-74	11	136.1	17.9	23	132.1	17.6	24	140.1	18.1	24	133.2	23.0
75+	17	149.3	16.8	27	151.9	24.8	12	141.2	21.3	19	142.7	22.6
Total Pop.*	168	129.9	19.5	225	119.1	21.4	211	129.1	17.4	262	118.0	20.0
Diastolic												
18-24	25	75.0	12.4	27	67.7	9.4	40	73.2	10.6	32	73.4	6.7
25-34	14	80.8	11.4	18	74.8	6.0	26	76.3	11.4	39	73.7	11.1
35-44	27	82.3	11.0	49	79.1	11.6	31	80.9	9.8	49	79.8	12.0
45-54	37	83.6	9.2	42	82.2	9.6	40	85.0	12.2	56	80.4	14.0
55-64	37	83.5	13.8	39	80.1	11.4	38	85.2	12.1	43	83.5	14.0
65-74	11	81.1	9.8	23	82.3	9.8	24	82.9	11.7	24	85.2	13.2
75+	17	80.0	10.6	27	89.1	14.9	12	79.1	9.7	19	83.7	15.9
Total Pop.*	168	81.1	11.6	225	79.3	12.2	211	80.8	12.0	262	79.9	13.1

* Total population means are age-sex adjusted to the total sample size.

TABLE 25 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS (mm.Hg) OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURE AMONG WHITE PERSONS 18-75+ YEARS OF AGE, WHO ARE NOT TAKING HIGH BLOOD PRESSURE MEDICATION AND HAVE LIVED 10 YEARS OR LESS IN: WEST DUNDEE OR McHENRY, ILLINOIS, 1976-77

Blood Pressure Age (Years)	West Dundee						McHenry					
	Male			Female			Male			Female		
	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation
Systolic												
18-24	51	121.9	12.7	84	105.0	10.1	14	113.6	14.0	21	102.5	10.9
25-34	106	123.4	12.4	128	106.4	12.4	50	122.5	12.0	70	107.2	12.2
35-44	57	122.5	14.8	78	110.2	15.4	40	126.0	15.4	36	108.3	14.8
45-54	36	125.9	17.1	35	120.2	19.1	25	127.9	13.1	26	113.9	21.9
55-64	19	121.9	14.1	15	126.9	16.2	26	132.1	15.7	64	129.2	20.3
65-74	5	123.0	15.3	17	145.4	18.4	85	141.9	22.8	67	132.0	17.1
75+	5	142.9	36.9	6	152.1	8.8	26	141.8	22.8	23	143.1	20.9
Total Pop. *	279	124.3	14.6	363	117.4†	17.5	266	127.8	20.2	307	114.5†	21.3
Diastolic												
18-24	51	73.4	10.1	84	71.1	7.3	14	67.3	10.9	21	72.2	6.9
25-34	106	76.4	10.4	128	73.3	10.4	50	79.2	9.2	70	75.2	10.8
35-44	57	81.2	9.3	78	75.4	10.8	40	82.3	9.4	36	77.9	9.2
45-54	36	82.1	12.5	35	82.9	12.5	25	85.7	9.6	26	81.8	14.3
55-64	19	80.6	12.7	15	81.4	13.6	26	82.7	9.5	64	87.2	15.0
65-74	5	71.1	13.1	17	90.7	16.7	85	86.2	13.8	67	85.7	14.4
75+	5	75.4	8.4	6	80.1	9.1	26	82.9	14.6	23	78.9	11.7
Total Pop. *	279	76.9	11.0	363	77.6	11.6	266	80.7	12.3	307	78.7	13.6

* Total population means are age-sex adjusted to the total sample size.
† $P < 0.05$ for total population means and $P = 0.06$ for age-specific means.

TABLE 26 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS (mm.Hg) OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURE AMONG WHITE PERSONS 18-75+ YEARS OF AGE, WHO DO NOT HAVE DEFINITE HYPERTENSION,[+] NOR ARE CURRENTLY TAKING HIGH BLOOD PRESSURE MEDICATION, AND HAVE LIVED GREATER THAN 10 YEARS IN: WEST DUNDEE OR McHENRY, ILLINOIS, 1976-77

Blood Pressure	West Dundee						McHenry					
	Male			Female			Male			Female		
Age (Years)	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation
Systolic												
18-24	22	122.7	10.1	27	103.4	10.8	39	122.1	11.1	32	108.6	9.8
25-34	13	124.7	16.9	18	108.2	11.6	25	119.2	11.0	38	104.7	10.6
35-44	24	118.7	9.4	46	110.1	11.4	26	116.9	11.8	43	107.9	12.9
45-54	33	123.9	13.5	37	117.3	15.7	32	125.0	11.6	52	113.5	13.7
55-64	32	126.6	14.0	34	119.1	16.6	32	129.8	13.8	32	113.1	13.6
65-74	10	133.8	17.0	21	128.0	11.4	21	135.5	11.5	19	124.9	12.0
75+	14	143.4	10.8	15	138.3	16.7	9	132.7	14.2	13	135.6	18.9
Total Pop. *	148	125.8	14.3	198	115.3†	16.5	184	125.0	13.2	229	113.0 †	14.8
Diastolic												
18-24	22	71.6	8.2	27	67.7	9.4	39	72.7	10.1	32	73.4	6.7
25-34	13	79.5	10.7	18	74.8	6.0	25	75.0	9.6	38	72.9	9.8
35-44	24	79.6	7.5	46	77.0	8.0	26	77.9	7.6	43	76.7	8.8
45-54	33	82.0	8.2	37	79.7	6.8	32	80.5	7.9	52	77.9	10.0
55-64	32	79.6	9.3	34	77.4	9.3	32	81.9	7.4	32	76.7	7.5
65-74	10	79.3	8.3	21	80.7	8.5	21	79.8	8.5	19	80.4	6.3
75+	14	79.2	10.9	15	82.2	7.8	9	74.6	5.6	13	76.3	11.4
Total Pop. *	148	78.5	9.3	198	76.7	9.0	184	77.8	9.1	229	76.3	9.0

* Total population means are age-sex adjusted to the total sample size.

[+] Systolic blood pressure of at least 160 mm.Hg or diastolic blood pressure of at least 95 mm.Hg.

† $P < 0.05$ for total population means.

TABLE 27 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS (mm.Hg) OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURE AMONG WHITE PERSONS 18-75+ YEARS OF AGE, WHO DO NOT HAVE DEFINITE HYPERTENSION,+ NOR ARE CURRENTLY TAKING HIGH BLOOD PRESSURE MEDICATION, AND HAVE LIVED 10 YEARS OR LESS IN: WEST DUNDEE OR McHENRY, ILLINOIS, 1976-77

Blood Pressure Age (Years)	West Dundee						McHenry					
	Male			Female			Male			Female		
	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation
Systolic												
18-24	50	121.6	12.6	84	105.0	10.1	13	112.3	13.7	21	102.5	10.9
25-34	99	122.5	12.0	124	105.2	10.9	48	122.3	12.1	69	106.9	12.0
35-44	51	120.0	12.6	74	108.1	12.3	37	123.5	11.2	34	107.6	14.6
45-54	29	120.6	13.6	26	113.3	14.9	21	124.2	9.8	20	105.5	14.2
55-64	17	120.1	11.6	14	124.9	14.8	21	126.8	9.6	49	122.6	14.4
65-74	5	123.0	15.3	11	136.9	14.3	55	130.0	14.3	52	126.4	12.7
75+	4	127.8	17.2	4	148.9	9.0	16	131.8	18.7	18	137.4	18.6
Total Pop. *	255	121.8	12.5	337	113.3†	14.1	211	123.1	13.5	263	111.0†	17.2
Diastolic												
18-24	50	73.0	9.7	84	71.1	7.3	13	65.0	7.2	21	72.2	6.9
25-34	99	74.8	8.9	124	72.3	8.7	48	78.3	8.1	69	74.6	9.7
35-44	51	79.4	8.0	74	73.9	8.7	37	80.7	6.9	34	76.4	7.7
45-54	29	77.1	7.7	26	77.4	8.3	21	82.6	6.2	20	75.6	8.6
55-64	17	77.2	6.8	14	79.4	11.5	21	79.9	8.0	49	80.6	7.5
65-74	5	71.1	13.1	11	80.9	8.1	55	79.8	8.1	52	79.7	8.2
75+	4	73.4	8.3	4	78.4	5.7	16	74.6	8.3	18	76.5	10.8
Total Pop. *	255	75.3	8.9	337	74.6	8.7	211	77.6	8.4	263	75.8	8.9

* Total population means are age-sex adjusted to the total sample size.

+ Systolic blood pressure of at least 160 mm.Hg or diastolic blood pressure of at least 95 mm.Hg.

† $P < 0.05$ for total population and age-specific means.

TABLE 28 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS (mm.Hg) OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURE AMONG WHITE PERSONS 18-75+ YEARS OF AGE WHO DO NOT HAVE DEFINITE HYPERTENSION[+] NOR ARE CURRENTLY TAKING HIGH BLOOD PRESSURE MEDICATION: WEST DUNDEE AND McHENRY, ILLINOIS, 1976-77

Blood Pressure Age (Years)	West Dundee						McHenry					
	Male			Female			Male			Female		
	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation
Systolic												
18-24	72	122.0	11.8	111	104.6	10.2	52	119.6	12.4	53	106.4	10.6
25-34	113	122.7	12.5	143	105.6	10.9	73	121.3	11.8	108	106.2	11.5
35-44	75	119.6	11.6	120	108.9	12.0	63	120.7	11.8	77	107.8	13.6
45-54	62	122.3	13.6	63	115.6	15.4	53	124.7	10.8	72	111.3	14.2
55-64	49	124.3	13.5	48	120.8	16.1	53	128.6	12.3	81	118.8	14.8
65-74	15	130.2	16.8	32	131.1	13.0	76	131.5	13.7	71	126.0	12.5
75+	18	139.9	13.6	19	140.6	15.8	25	132.2	16.9	31	136.7	18.4
Total Pop.	404	124.0	13.3	536	113.5	15.4	395	124.1	13.4	493	112.3	16.2
Diastolic												
18-24	72	72.6	9.2	111	70.3	7.9	52	70.6	10.0	53	72.9	6.8
25-34	113	75.3	9.1	143	72.7	8.4	73	77.2	8.7	108	84.1	9.8
35-44	75	79.5	7.8	120	75.1	8.5	63	79.5	7.3	77	76.6	8.3
45-54	62	79.8	8.3	63	78.7	7.5	53	81.3	7.3	72	77.3	9.6
55-64	49	78.8	8.5	48	78.0	9.9	53	81.1	7.7	81	79.0	7.7
65-74	15	76.6	10.5	32	80.8	8.2	76	79.8	8.2	71	79.9	7.7
75+	18	77.9	10.4	19	81.4	7.4	25	74.6	8.3	31	76.4	10.9
Total Pop.	404	77.0	9.2	536	75.5	9.0	395	77.8	8.8	493	76.1	9.0

[*] Total population means are age-sex adjusted to the total sample size.

[+] Systolic blood pressure of at least 160 mm. Hg. or diastolic blood pressure of at least 95 mm. Hg.

TABLE 29 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS (mm.Hg) OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURE AMONG WHITE PERSONS 18-75+ YEARS OF AGE WITH DEFINITE HYPERTENSION⁺ OR WHO ARE CURRENTLY TAKING HIGH BLOOD PRESSURE MEDICATION: WEST DUNDEE AND McHENRY, ILLINOIS, 1976-77

Blood Pressure Age (Years)	West Dundee						McHenry					
	Male			Female			Male			Female		
	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation
Systolic												
18-24	5	142.7	25.6	1	106.0	0	2	134.2	5.9	0	0	0
25-34	9	139.0	12.8	4	141.1	7.0	4	138.3	17.8	3	116.0	22.1
35-44	17	142.8	22.1	13	137.3	16.3	11	143.0	18.7	11	136.0	18.3
45-54	27	140.7	14.7	27	134.5	15.1	21	142.4	17.6	17	137.7	19.9
55-64	20	148.6	27.3	27	141.1	22.9	24	151.2	18.3	55	145.1	22.4
65-74	14	148.7	19.4	28	146.1	25.4	52	154.2	22.7	66	147.2	21.7
75+	10	167.7	18.5	30	158.5	24.9	22	159.2	18.1	25	157.7	18.9
Total Pop.*	102	148.2	21.3	130	144.4	23.2	136	149.2	20.5	177	145.1	22.1
Diastolic												
18-24	5	94.3	11.5	1	64.7	0	2	95.8	1.2	0	0	0
25-34	9	98.1	2.9	4	104.5	10.5	4	103.2	3.7	3	94.7	29.2
35-44	17	97.2	8.0	13	99.1	12.5	11	100.8	11.4	11	101.2	6.9
45-54	27	93.9	11.0	27	95.1	9.6	21	97.4	11.5	17	100.3	14.5
55-64	20	93.1	16.4	27	96.2	15.0	24	97.4	14.3	55	98.8	15.7
65-74	14	88.1	14.7	28	92.2	17.2	52	94.9	14.2	66	94.0	16.7
75+	10	85.5	7.3	30	92.3	16.4	22	90.0	11.9	25	92.6	17.8
Total Pop.*	102	91.6	12.0	130	94.4	14.8	136	96.4	13.1	177	96.2	16.2

* Total population means are age-sex adjusted to the total sample size.

+ Systolic blood pressure of at least 160 mm. Hg or diastolic blood pressure of at least 95 mm. Hg.

TABLE 30 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS (mm. Hg) OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURE AMONG WHITE PERSONS 18-75+ YEARS OF AGE, ON HIGH BLOOD PRESSURE MEDICINE: WEST DUNDEE AND McHENRY, ILLINOIS, 1976-77

Blood Pressure	West Dundee						McHenry					
	Male			Female			Male			Female		
Age (Years)	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation
Systolic												
18-24	1	116.0	--	1	106.0	--	0	--	--	0	--	--
25-34	1	162.0	--	0	--	--	1	146.3	--	1	90.7	--
35-44	8	139.4	28.2	6	132.9	14.3	3	149.8	9.0	3	139.3	14.1
45-54	16	133.5	10.9	13	133.2	15.5	9	132.7	18.3	7	128.6	19.0
55-64	13	138.7	19.1	21	140.0	24.9	13	142.1	14.3	28	144.4	22.6
65-74	13	147.9	20.0	20	138.7	25.3	19	136.5	15.8	45	144.7	21.3
75+	6	157.2	11.5	16	150.8	25.7	9	158.2	16.8	14	155.5	18.5
Total Pop.*	58	142.4	19.4	77	140.5	23.6	54	141.2	17.4	98	143.3	22.0
Diastolic												
18-24	1	75.3	--	1	64.7	--	0	--	--	0	--	--
[illegible]34	1	96.7	--	0	--	--	1	100.0	--	1	61.3	--
35-44	8	95.0	8.7	6	90.0	10.0	3	106.7	17.6	3	98.2	7.6
45-54	16	89.3	11.5	13	90.2	9.9	9	90.4	11.6	7	90.3	10.3
55-64	13	84.4	11.8	21	94.8	16.7	13	95.8	15.6	28	91.7	16.3
65-74	13	87.3	15.0	20	86.4	16.0	19	88.6	12.3	45	88.5	15.9
75+	6	86.6	7.1	16	89.3	15.4	9	81.8	8.4	14	91.2	21.3
Total Pop.*	58	87.7	11.8	77	90.0	15.0	54	91.3	13.7	98	90.1	16.4

* Total population means are age-sex adjusted to the total sample size.

TABLE 31 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS (mm. Hg) OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURE AMONG WHITE PERSONS 18-75+ YEARS OF AGE, NO LONGER TAKING HIGH BLOOD PRESSURE MEDICINE: WEST DUNDEE AND McHENRY, ILLINOIS, 1976-77

Blood Pressure	West Dundee						McHenry					
	Male			Female			Male			Female		
Age (Years)	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation
Systolic												
18-24	0	--	--	1	111.3	--	1	146.0	--	0	--	--
25-34	3	142.3	9.1	3	103.3	5.8	0	--	--	4	116.5	6.6
35-44	5	147.9	20.0	4	123.8	17.6	7	132.5	16.0	4	133.6	16.6
45-54	4	132.5	11.1	5	133.3	16.5	5	140.0	15.2	0	--	--
55-64	3	153.3	32.7	3	117.8	12.3	3	158.9	13.7	6	146.4	19.9
65-74	3	136.4	19.9	4	124.9	21.7	5	158.0	17.5	6	140.3	21.3
75+	1	156.0	--	5	168.7	40.6	2	144.3	26.9	1	149.3	--
Total Pop.*	19	143.4	18.8	25	131.6	30.0	23	144.6	18.4	21	136.2	19.6
Diastolic												
18-24	0	--	--	1	68.0	--	1	75.3	--	0	--	--
25-34	3	79.1	18.4	3	74.2	12.2	0	--	--	4	78.3	4.4
35-44	5	96.1	12.4	4	87.3	19.9	7	84.3	6.0	4	91.4	12.4
45-54	4	84.0	3.6	5	94.3	8.9	5	92.7	5.1	0	--	--
55-64	3	99.7	19.1	3	77.6	3.7	3	94.4	6.5	6	96.1	14.1
65-74	3	81.6	15.0	4	88.1	21.1	5	100.1	9.8	6	85.8	7.9
75+	1	92.7	--	5	90.2	12.1	2	78.5	9.2	1	84.0	--
Total Pop.*	19	89.7	14.3	25	85.4	14.7	23	89.2	10.0	21	88.6	11.6

* Total population means are age-sex adjusted to the total sample size.

on high blood pressure medication than the comparable male age-groups in McHenry (See Table 18 to get total number of individuals for each age group). A significant difference, using the Mantel-Haenszel Test (59), was found for the above comparison. Since there was not a significant difference found for individuals either having definite hypertension or taking blood pressure medication between the two communities (Table 29), it can be concluded that more males with hypertension in West Dundee take medication than males with hypertension in McHenry. It is not known why more males in West Dundee take medication for their hypertension than males in McHenry. When the above comparison is made for females, no significant difference was found.

Another important factor that could be masking a possible effect of barium on blood pressure is the home water softener. As mentioned previously, water softeners remove barium from the water. As a consequence, blood pressures for males and females in West Dundee, who do not have home water softeners, were compared to a similar population of males and females in McHenry (Table 32). Males and females from West Dundee without water softeners did not have blood pressures that were significantly higher than their counterparts in McHenry.

Since water softeners could also possibly mask the effect of barium as related to residence time in the community, West Dundee male and female blood pressures were compared to McHenry male and female blood pressures to see if there were any differences in the blood pressures of those individuals who do not have home water softeners, and have lived greater than 10 years in their respective communities (Table 33). A significant difference was found when West Dundee male mean age-specific and total population mean ($P = 0.06$) systolic blood pressures were compared to these same mean blood pressures in McHenry males. No significant differences were found between female systolic blood pressures or between male or female diastolic blood pressures. When the same comparisons were made for individuals living 10 years or less in their respective communities, no significant differences were found between male and female systolic or diastolic blood pressures (Table 34). The West Dundee female systolic blood pressures were elevated in the 55-64, 65-74 and 75+ age groups in comparison to McHenry's female systolic blood pressures for these same three age groupings.

The next series of Tables (35-40) deal with those individuals in West Dundee and McHenry who do not have home waters, are not taking high blood pressure medication, do not have hypertension, and have lived either greater than 10 years or 10 years and less in the community. In Table 35, no significant differences were found when West Dundee male and female blood pressures were compared to a similar population of McHenry males and females who do not have home water softeners and are not taking high blood pressure medication. However, when a correction is made for time of residence in the community, a significant difference is found for systolic blood pressures between West Dundee and McHenry males living greater than 10 years in the community (Table 36). The total population mean and mean age-specific systolic blood pressures had P values of 0.05 and 0.08 respectively. The only significant difference (Table 37) found for individuals living 10 years and less in their community, without water softeners, and not taking high blood pressure medication was between West Dundee and McHenry female systolic mean

TABLE 32 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS (mm.Hg) OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURE AMONG WHITE PERSONS 18-75+ YEARS OF AGE, WHO DO NOT HAVE HOME WATER SOFTENERS: WEST DUNDEE OR McHENRY, ILLINOIS, 1976-77

Blood Pressure Age (Years)	West Dundee						McHenry					
	Male			Female			Male			Female		
	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation
Systolic												
18-24	48	121.7	12.4	61	103.9	9.8	23	119.9	13.3	25	104.7	11.1
25-34	81	123.3	13.2	86	107.6	13.0	28	122.8	12.5	36	107.9	11.6
35-44	61	123.6	14.4	80	110.5	13.9	22	126.1	17.0	26	113.5	19.7
45-54	49	130.1	16.6	59	122.1	18.0	25	125.3	14.8	35	121.7	19.9
55-64	39	134.1	23.9	40	131.1	20.1	17	139.2	19.6	34	132.0	18.3
65-74	17	144.6	19.9	39	139.1	22.6	34	141.1	18.1	39	132.5	16.6
75+	19	150.7	23.6	38	150.9	24.2	19	150.6	23.3	19	147.2	18.4
Total Pop. *	314	129.8	18.4	403	120.6	22.5	168	129.4	19.6	214	120.1	21.1
Diastolic												
18-24	48	73.7	9.9	61	71.5	8.1	23	72.0	12.0	25	72.4	7.0
25-34	81	77.7	10.6	86	74.7	10.7	28	78.7	10.5	36	74.6	11.1
35-44	61	83.0	9.8	80	76.8	11.4	22	85.3	12.1	26	82.2	13.1
45-54	49	84.0	11.0	59	83.3	10.4	25	84.6	12.7	35	86.2	15.8
55-64	39	84.3	14.2	40	87.0	13.5	17	87.3	13.3	34	88.0	13.2
65-74	17	85.5	13.7	39	85.8	13.9	34	85.6	13.6	39	86.9	14.2
75+	19	79.9	9.5	38	88.8	15.1	19	85.0	12.8	19	87.8	19.8
Total Pop. *	314	80.8	11.6	403	80.1	13.0	168	82.0	13.2	214	81.7	14.7

* Total population means are age-sex adjusted to the total sample size.

TABLE 33 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS (mm.Hg) OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURE AMONG WHITE PERSONS 18-75+ YEARS OF AGE, WHO DO NOT HAVE WATER SOFTENERS AND HAVE LIVED GREATER THAN 10 YEARS IN: WEST DUNDEE OR McHENRY, ILLINOIS, 1976-77

Blood Pressure Age (Years)	West Dundee						McHenry					
	Male			Female			Male			Female		
	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation
Systolic												
18-24	13	122.2	11.7	8	105.6	14.2	16	122.1	12.1	16	106.2	11.2
25-34	8	127.8	18.6	7	109.3	14.1	6	122.8	9.3	13	106.6	12.8
35-44	17	124.1	16.4	24	112.1	14.1	12	125.6	13.2	16	114.9	20.5
45-54	20	135.0	14.7	29	120.8	17.5	16	125.1	13.8	23	119.2	17.8
55-64	25	141.8	24.7	29	128.6	19.2	10	138.3	20.1	17	136.8	18.2
65-74	16	145.1	20.4	23	136.4	23.0	8	143.5	25.1	11	130.7	18.6
75+	15	152.9	17.4	30	151.9	26.2	8	140.9	21.9	10	149.8	16.8
Total Pop. *	114	135.5†	20.9	150	125.5	24.6	76	131.2†	17.8	106	125.8	21.6
Diastolic												
18-24	13	74.3	7.9	8	72.0	11.7	16	72.6	11.4	16	71.9	7.0
25-34	8	82.9	12.5	7	76.9	4.2	6	74.3	10.2	13	75.6	13.9
35-44	17	83.5	12.4	24	79.3	12.5	12	87.3	10.5	16	82.8	13.3
45-54	20	86.6	7.8	29	82.6	9.5	16	83.0	14.2	23	84.8	16.0
55-64	25	86.9	14.0	29	85.3	12.6	10	87.7	15.8	17	94.0	13.7
65-74	16	85.9	14.0	23	85.9	15.4	8	85.3	8.8	11	82.7	8.4
75+	15	80.1	10.6	30	91.4	15.5	8	81.1	11.0	10	94.5	19.6
Total Pop. *	114	83.2	12.1	150	82.9	13.6	76	82.4	13.1	106	85.4	15.3

* Total population means are age-sex adjusted to the total sample size.

† $P = 0.06$ for total population means and $P < 0.05$ for age-specific means.

TABLE 34 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS (mm.Hg) OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURE AMONG WHITE PERSONS 18-75+ YEARS OF AGE, WHO DO NOT HAVE WATER SOFTENERS AND HAVE LIVED 10 YEARS OR LESS IN: WEST DUNDEE OR McHENRY, ILLINOIS, 1976-77

Blood Pressure	West Dundee						McHenry					
	Male			Female			Male			Female		
Age (Years)	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation
Systolic												
18-24	35	121.6	12.9	53	103.7	9.2	7	115.0	15.3	9	102.1	11.0
25-34	73	122.7	12.6	79	107.4	13.0	22	122.8	13.4	23	108.6	11.1
35-44	44	123.4	13.7	56	109.8	13.9	10	126.7	21.5	10	111.3	19.1
45-54	29	126.7	17.1	30	123.3	18.6	9	125.6	17.3	12	126.6	23.6
55-64	14	120.3	15.0	11	137.6	21.9	7	140.4	20.4	17	127.2	17.7
65-74	1	135.3	0.0	16	143.1	22.2	26	140.3	15.9	28	133.3	16.0
75+	4	142.8	42.7	8	147.1	15.3	11	157.7	22.7	9	144.3	20.7
Total Pop. *	200	125.2	14.9	253	117.6	19.2	92	127.4	20.9	108	116.2	20.7
Diastolic												
18-24	35	73.4	10.7	53	71.4	7.6	7	70.8	14.3	9	73.4	7.3
25-34	73	77.1	10.4	79	74.6	11.1	22	79.8	10.5	23	74.0	9.6
35-44	44	82.8	8.8	56	75.8	10.8	10	82.8	13.9	10	81.2	13.3
45-54	29	82.3	12.5	30	84.0	11.2	9	87.6	9.4	12	88.8	15.7
55-64	14	79.6	13.9	11	91.6	15.4	7	86.8	9.9	17	82.0	9.8
65-74	1	78.7	0.0	16	85.6	12.0	26	85.7	14.9	28	88.6	15.7
75+	4	78.9	3.5	8	79.3	9.1	11	87.9	13.8	9	80.3	18.2
Total Pop. *	200	78.7	11.0	253	78.2	11.8	92	81.5	13.2	108	79.6	14.2

* Total population means are age-sex adjusted to the total sample size.

TABLE 35 AGE- SPECIFIC MEANS AND STANDARD DEVIATIONS (mm.Hg) OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURE AMONG WHITE PERSONS 18-75+ YEARS OF AGE, WHO DO NOT HAVE WATER SOFTENERS AND ARE NOT TAKING HIGH BLOOD PRESSURE MEDICATION: WEST DUNDEE OR McHENRY, ILLINOIS, 1976-77

Blood Pressure	West Dundee						McHenry					
	Male			Female			Male			Female		
Age (Years)	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation
Systolic												
18-24	47	121.9	12.6	60	103.9	9.9	23	119.9	13.3	25	104.7	11.1
25-34	80	122.8	12.6	86	107.6	13.0	27	121.9	11.8	36	107.9	11.6
35-44	56	123.1	14.8	76	109.4	13.1	21	125.2	17.0	25	112.0	18.6
45-54	39	129.5	18.0	50	121.0	18.5	22	126.4	15.1	31	120.5	20.0
55-64	31	132.9	25.8	28	128.0	18.4	15	140.0	19.5	26	127.6	17.1
65-74	7	138.5	14.4	26	136.7	18.7	30	142.3	18.9	29	130.7	16.3
75+	16	149.8	25.5	25	151.7	22.8	16	146.2	22.4	13	143.9	18.5
Total Pop. *	276	128.1	18.0	351	117.5	20.5	154	128.3	19.2	185	116.9	19.7
Diastolic												
18-24	47	73.6	10.0	60	71.6	8.1	23	72.0	12.0	25	72.4	7.0
25-34	80	77.5	10.5	86	74.7	10.7	27	77.9	9.8	36	74.6	11.1
35-44	56	82.2	9.9	76	76.2	11.0	21	84.9	12.2	25	81.2	12.4
45-54	39	83.1	11.4	50	82.8	10.9	22	85.5	13.1	31	85.6	16.5
55-64	31	83.6	14.8	28	82.8	11.4	15	87.0	13.3	26	86.0	12.9
65-74	7	81.0	8.6	26	85.0	10.7	30	84.8	12.4	29	85.3	12.8
75+	16	79.1	9.6	25	88.7	15.4	16	84.7	13.9	13	81.6	16.1
Total Pop. *	276	79.6	11.4	351	78.6	12.0	154	81.3	13.0	185	79.9	13.7

* Total population means are age-sex adjusted to the total sample size.

TABLE 36 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS (mm.Hg) OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURE AMONG WHITE PERSONS 18-75+ YEARS OF AGE, WHO DO NOT HAVE WATER SOFTNERS, ARE NOT TAKING HIGH BLOOD PRESSURE MEDICATION AND HAVE LIVED GREATER THAN 10 YEARS IN: WEST DUNDEE OR McHENRY, ILLINOIS, 1976-77

Blood Pressure Age (Years)	West Dundee						McHenry					
	Male			Female			Male			Female		
	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation
Systolic												
18-24	12	122.7	12.1	8	105.6	14.2	16	122.1	12.1	16	106.2	11.2
25-34	8	127.8	18.6	7	109.3	14.1	6	122.8	9.3	13	106.6	12.8
35-44	16	124.5	16.9	23	111.6	14.2	11	123.9	12.5	16	114.9	20.5
45-54	14	137.2	17.0	25	120.2	17.6	14	126.0	14.0	20	117.9	17.4
55-64	17	143.4	28.4	19	126.4	19.4	10	138.3	20.1	12	132.7	17.0
65-74	6	139.0	15.7	14	129.9	12.9	7	145.4	26.5	9	131.3	19.6
75+	12	152.2	19.0	20	150.9	25.4	7	138.0	21.9	7	151.1	16.2
Total Pop. *	85	134.6†	21.6	116	121.8	22.6	71	129.9†	17.8	93	122.9	20.7
Diastolic												
18-24	12	74.2	8.2	8	72.0	11.7	16	72.6	11.4	16	71.9	7.0
25-34	8	82.9	12.5	7	76.9	4.2	6	74.3	10.2	13	75.6	13.9
35-44	16	83.0	12.6	23	78.8	12.5	11	86.8	10.8	16	82.8	13.3
45-54	14	86.5	8.1	25	82.3	9.9	14	83.9	14.8	20	83.9	16.7
55-64	17	87.0	15.1	19	80.7	10.1	10	87.7	15.8	12	92.4	13.4
65-74	6	81.3	9.3	14	82.8	9.2	7	36.7	8.5	9	81.7	7.7
75+	12	79.2	11.1	20	90.5	16.3	7	79.7	11.1	7	89.8	15.9
Total Pop. *	85	82.1	12.0	116	80.8	12.3	71	81.9	13.4	93	83.3	14.4

* Total population means are age-sex adjusted to the total sample size.

† P = 0.05 for total population means and P = 0.08 for age-specific means.

TABLE 37 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS (mm.Hg) OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURE AMONG WHITE PERSONS 18-75+ YEARS OF AGE, WHO DO NOT HAVE WATER SOFTENERS, ARE NOT TAKING HIGH BLOOD PRESSURE MEDICATION AND HAVE LIVED 10 YEARS OR LESS IN: WEST DUNDEE OR McHENRY, ILLINOIS, 1976-77

Blood Pressure	West Dundee						McHenry					
	Male			Female			Male			Female		
Age (Years)	Pop. Size	Mean	Standard Deviation	Pop. Size	† Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	† Mean	Standard Deviation
Systolic												
18-24	35	121.6	12.9	52	103.7	9.2	7	115.0	15.3	9	102.1	11.0
25-34	72	122.2	11.8	79	107.4	13.0	21	121.7	12.6	23	108.6	11.1
35-44	40	122.6	14.0	53	108.5	12.5	10	126.7	21.5	9	107.0	14.2
45-54	25	125.1	17.4	25	121.7	19.8	8	127.1	17.9	11	125.2	24.2
55-64	14	120.3	15.0	9	131.5	16.6	5	143.4	20.2	14	123.3	16.6
65-74	1	135.3	0.0	12	144.8	21.5	23	141.4	16.6	20	130.4	15.2
75+	4	142.8	42.7	5	154.9	6.2	9	152.6	21.9	6	135.4	18.7
Total Pop. *	191	124.5	14.7	235	115.4	18.1	83	126.9	20.4	92	113.0	18.8
Diastolic												
18-24	35	73.4	10.7	52	71.5	7.9	7	70.8	14.3	9	73.4	7.3
25-34	72	76.8	10.2	79	74.6	11.1	21	78.9	9.7	23	74.0	9.6
35-44	40	81.9	8.7	53	75.1	10.3	10	82.8	13.9	9	78.4	10.5
45-54	25	81.2	12.8	25	83.3	12.0	8	88.3	9.9	11	88.9	16.4
55-64	14	79.6	13.9	9	87.2	13.3	5	85.7	7.0	14	80.5	9.8
65-74	1	78.7	0.0	12	87.6	12.0	23	84.2	13.5	20	86.9	14.4
75+	4	78.9	3.5	5	81.5	9.4	9	88.6	15.2	6	72.1	10.8
Total Pop. *	191	78.2	10.9	235	77.5	11.4	83	80.9	12.8	92	78.0	12.9

* Total population means are age-sex adjusted to the total sample size.

† P = 0.08 for systolic age-specific means.

age-specific blood pressures (P = 0.08).

A comparison between West Dundee and McHenry blood pressures for individuals who do not have home water softeners, who do not have definite hypertension, and who are not taking high blood pressure medication was not found to be statistically significant (Table 38). However, when the above comparison was made for those individuals living greater than 10 years in the community, a significant difference was found between West Dundee and McHenry male systolic total population and age-specific mean blood pressures (Table 39). When the same comparison was made between West Dundee and McHenry males and females living 10 years and less in the community, only female systolic age-specific mean blood pressures were significantly different (Table 40).

Another factor considered in the data analysis was the comparison of blood pressures of males and females from West Dundee who have never smoked against the nonsmoking males and females in McHenry (Table 41). No significant differences in blood pressures were found when the nonsmoking persons from West Dundee were compared to the nonsmoking persons in McHenry. Likewise, no differences in blood pressures were found when the nonsmoking persons from West Dundee or McHenry were compared to the total study population of West Dundee and McHenry (Tables 18 and 41). In addition, the above findings apply to individuals from West Dundee and McHenry who have smoked sometime during their lifetime (Table 42). When the blood pressures between the nonsmokers and smokers from West Dundee and McHenry were compared, no significant differences were noted (Tables 41 and 42). Since no differences in blood pressures between the nonsmokers and smokers in the two communities were noted, it is felt that smoking did not mask any possible effect of barium on blood pressure.

A separate analysis of blood pressures was made for those persons in West Dundee and McHenry who were determined obese by triceps skinfold readings (Table 43), and for those who were determined nonobese by skinfold readings (Table 44). Males were determined obese if the triceps skinfold measurement was greater than 20 mm., while females were obese if this measurement was greater than 25 mm. (69). No statistical differences were found when blood pressures for obese or nonobese males and females from West Dundee were compared respectively to McHenry obese or nonobese males and females.

In addition to blood pressure readings, pulse rates of males and females from West Dundee and McHenry were taken during the study period (Table 45). No significant differences ($P > 0.05$) were found when age-specific or total population pulse rate means for West Dundee males and females were compared in a similar fashion to McHenry males and females.

In summary, blood pressure data were analyzed using the signed rank and weighted Z tests to see if there were any differences between systolic and diastolic blood pressures of males and females from West Dundee and McHenry. The blood pressure data were analyzed in the following manner for both communities: (1) all males and females in the study population, (2) males and females who have lived greater than 10 years or 10 years and less in West Dundee and McHenry, (3) males and females who are not taking high blood

TABLE 38 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS (mm.Hg) OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURE AMONG WHITE PERSONS 18-75+ YEARS OF AGE, WHO DO NOT HAVE HOME WATER SOFTENERS, WHO DO NOT HAVE DEFINITE HYPERTENSION,+ NOR ARE CURRENTLY TAKING HIGH BLOOD PRESSURE MEDICATION: WEST DUNDEE OR McHENRY, ILLINOIS, 1976-77

Blood Pressure Age (Years)	West Dundee						McHenry					
	Male			Female			Male			Female		
	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation
Systolic												
18-24	46	121.5	12.5	60	103.9	9.9	21	118.6	13.0	25	104.7	11.1
25-34	75	122.1	12.4	82	106.0	10.9	26	122.2	12.0	35	107.2	11.0
35-44	49	119.7	10.6	73	108.3	12.1	16	120.3	10.5	21	108.1	14.3
45-54	31	123.9	14.4	42	117.9	16.8	17	120.7	10.8	24	114.4	15.2
55-64	27	124.9	13.6	25	125.6	17.1	12	133.0	14.6	20	122.2	13.4
65-74	6	135.0	12.1	22	131.7	14.0	22	135.3	11.0	23	125.0	10.1
75+	12	138.6	16.3	15	141.6	15.9	9	134.0	13.4	10	142.0	16.7
Total Pop. *	246	124.0	13.3	319	113.9	16.6	123	123.8	13.5	158	112.8	16.2
Diastolic												
18-24	46	73.2	9.6	60	71.6	8.1	21	69.8	9.8	25	72.4	7.0
25-34	75	76.1	9.3	82	73.3	8.4	26	76.9	8.6	35	73.7	9.8
35-44	49	79.8	7.3	73	74.8	8.6	16	79.9	7.9	21	77.3	8.6
45-54	31	78.9	8.4	42	79.7	8.2	17	79.9	8.1	24	79.2	10.3
55-64	27	78.8	7.5	25	80.7	9.9	12	82.9	6.5	20	80.7	7.5
65-74	6	78.0	3.8	22	82.1	8.4	22	79.8	8.8	23	80.4	7.2
75+	12	77.5	9.8	15	81.8	7.2	9	76.0	8.9	10	74.8	10.0
Total Pop. *	246	77.1	8.8	319	76.2	9.1	123	77.3	9.2	158	76.3	9.2

* Total population means are age-sex adjusted to the total sample size.

+ Systolic blood pressure of at least 160 mm.Hg. or diastolic blood pressure of at least 95 mm.Hg.

TABLE 39 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS (mm.Hg) OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURE PRESSURE AMONG WHITE PERSONS 18-75+ YEARS OF AGE, WHO DO NOT HAVE WATER SOFTENERS, WHO DO NOT HAVE DEFINITE HYPERTENSION,$^{+}$ NOR ARE CURRENTLY TAKING HIGH BLOOD PRESSURE MEDICATION, AND HAVE LIVED GREATER THAN 10 YEARS IN: WEST DUNDEE OR McHENRY, ILLINOIS, 1976-77

Blood Pressure	West Dundee						McHenry					
	Male			Female			Male			Female		
Age (Years)	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation
Systolic												
18-24	12	122.7	12.1	8	105.6	14.2	15	120.9	11.7	16	106.2	11.2
25-34	7	127.1	19.9	7	109.3	14.1	6	122.8	9.3	12	104.5	10.9
35-44	14	120.4	11.1	22	110.2	12.9	7	120.2	13.2	13	108.7	14.4
45-54	11	132.1	12.9	23	120.5	18.2	10	119.4	8.7	18	115.8	15.7
55-64	14	131.8	12.7	17	124.2	18.3	8	131.6	16.0	7	124.6	11.9
65-74	5	134.9	13.6	14	129.9	13.0	6	136.2	11.4	8	125.2	7.7
75+	9	144.0	12.9	12	138.9	16.5	5	129.2	15.5	4	151.8	6.3
Total Pop. *	72	129.2†	14.7	103	118.6	18.4	57	124.8†	13.0	78	117.5	16.6
Diastolic												
18-24	12	74.2	8.2	8	72.0	11.7	15	71.1	10.0	16	71.9	7.0
25-34	7	80.8	12.0	7	76.9	4.2	6	74.3	10.2	12	73.0	10.7
35-44	14	79.6	8.4	22	76.8	8.5	7	81.1	9.7	13	78.1	9.0
45-54	11	83.9	6.3	23	80.5	8.0	10	76.3	8.0	18	80.2	11.1
55-64	14	81.0	7.3	17	79.0	9.3	8	82.8	7.6	7	84.3	6.4
65-74	5	77.9	4.3	14	82.8	9.2	6	84.2	5.6	8	80.1	6.3
75+	9	77.6	11.5	12	82.2	7.8	5	73.9	5.1	4	78.8	8.6
Total Pop. *	72	79.2	8.7	103	78.5	8.9	57	77.3	9.5	78	78.3	9.6

* Total population means are age-sex adjusted to the total sample size.

+ Systolic blood pressure of at least 160 mm.Hg or diastolic blood pressure of at least 95 mm.Hg.

† $P < 0.05$ for total population and age-specific means.

TABLE 40 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS (mm.Hg) OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURE AMONG WHITE PERSONS 18-75+ YEARS OF AGE, WHO DO NOT HAVE WATER SOFTENERS, WHO DO NOT HAVE DEFINITE HYPERTENSION,[+] NOR ARE CURRENTLY TAKING HIGH BLOOD PRESSURE MEDICATION, AND HAVE LIVED 10 YEARS OR LESS IN WEST DUNDEE OR McHENRY, ILLINOIS, 1976-77

Blood Pressure	West Dundee						McHenry					
	Male			Female			Male			Female		
Age (Years)	Pop. Size	Mean	Standard Deviation	Pop. Size	† Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	† Mean	Standard Deviation
Systolic												
18-24	34	121.1	12.7	52	103.7	9.2	6	112.6	15.2	9	102.1	11.0
25-34	68	121.6	11.5	75	105.7	10.6	20	122.1	12.9	23	108.6	11.1
35-44	35	119.4	10.6	51	107.5	11.8	9	120.4	8.7	8	107.1	15.2
45-54	20	119.5	13.4	19	114.7	14.8	7	122.7	13.7	6	110.3	13.9
55-64	13	117.4	10.6	8	128.6	15.0	4	135.9	13.1	13	120.9	14.5
65-74	1	135.3	0.0	8	134.8	16.0	16	135.0	11.2	15	124.9	11.4
75+	3	122.6	16.8	3	152.4	6.7	4	140.0	8.6	6	135.4	18.7
Total Pop. *	174	121.6	11.8	216	111.7	14.3	66	122.7	14.1	80	110.1	15.8
Diastolic												
18-24	34	72.8	10.2	52	71.5	7.6	6	66.5	9.5	9	73.4	7.3
25-34	68	75.6	8.9	75	72.9	8.6	20	77.7	8.2	23	74.0	9.6
35-44	35	79.8	6.9	51	74.0	8.5	9	78.9	6.7	8	76.1	8.5
45-54	20	76.2	8.2	19	78.7	8.5	7	85.1	4.8	6	76.3	7.5
55-64	13	76.4	7.1	8	84.3	10.8	4	83.1	4.6	13	78.7	7.6
65-74	1	78.7	0.0	8	80.9	7.3	16	78.2	9.4	15	80.6	7.9
75+	3	77.4	2.2	3	80.1	5.5	4	78.6	12.6	6	72.1	10.8
Total Pop. *	174	76.3	8.7	216	75.0	8.8	66	77.3	9.1	80	75.3	8.7

* Total population means are age-sex adjusted to the total sample size.

[+] Systolic blood pressure of least 160 mm.Hg or diastolic blood pressure of at least 95 mm.Hg.

[†] $P < 0.05$ for systolic age-specific means.

TABLE 41 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS (mm. Hg) OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURE AMONG WHITE PERSONS 18-75+ YEARS OF AGE, WHO HAVE NEVER SMOKED: WEST DUNDEE AND McHENRY, ILLINOIS, 1976-77

Blood Pressure	West Dundee						McHenry					
	Male			Female			Male			Female		
Age (Years)	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation
Systolic												
18-24	38	123.3	12.4	51	104.8	10.1	26	120.6	13.1	28	107.7	10.6
25-34	40	123.0	11.4	67	104.9	13.1	38	120.4	11.6	41	104.7	11.8
35-44	17	122.0	14.4	47	111.1	16.4	20	123.2	14.2	36	111.1	19.3
45-54	20	126.2	19.6	36	119.0	15.2	12	132.9	17.4	39	113.1	15.2
55-64	19	127.2	22.3	38	128.0	22.6	16	130.6	16.2	63	128.8	21.9
65-74	8	143.4	19.6	34	136.2	17.3	36	141.9	20.4	88	136.0	19.2
75+	10	137.4	18.5	44	153.1	23.8	19	143.7	19.6	48	147.6	20.0
Total Pop.*	152	127.8	16.4	317	123.3	24.0	167	128.2	18.6	343	122.3	23.4
Diastolic												
18-24	38	73.4	10.8	51	70.8	7.9	26	72.3	9.8	28	74.8	6.5
25-34	40	77.9	11.9	67	72.8	10.2	38	77.9	7.2	41	73.3	9.8
35-44	17	80.9	9.6	47	77.3	11.8	20	82.9	10.5	36	81.5	13.1
45-54	20	86.4	15.3	36	83.7	9.3	12	89.9	12.1	39	78.4	12.6
55-64	19	84.2	16.5	38	84.2	15.1	16	88.9	14.9	63	86.1	13.5
65-74	8	80.5	14.2	34	85.1	14.4	36	86.6	11.6	88	87.2	15.1
75+	10	78.0	5.5	44	88.1	15.3	19	83.0	14.5	48	85.1	16.0
Total Pop.*	152	79.3	12.9	317	80.5	37.0	167	81.4	12.3	343	81.3	14.3

* Total population means are age-sex adjusted to the total sample size.

TABLE 42 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS (mm. Hg) OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURE AMONG WHITE PERSONS 18-76+ YEARS OF AGE, WHO HAVE SMOKED SOMETIME DURING THEIR LIFETIME: WEST DUNDEE AND McHENRY, ILLINOIS, 1976-77

Blood Pressure	West Dundee						McHenry					
	Male			Female			Male			Female		
Age (Years)	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation
Systolic												
18-24	39	123.3	15.3	61	104.4	10.4	28	119.8	12.2	25	104.4	10.5
25-34	82	124.3	14.1	80	108.0	11.4	39	123.9	13.4	70	107.5	11.8
35-44	75	124.3	17.2	86	112.0	14.3	54	124.4	15.6	52	111.5	15.4
45-54	69	128.4	15.3	54	122.8	18.9	61	129.1	15.0	50	118.8	20.6
55-64	50	132.9	21.1	39	128.1	19.7	61	137.0	18.0	73	130.0	22.8
65-74	21	137.5	20.6	26	140.6	25.2	92	140.3	21.4	49	136.5	27.8
75+	18	156.8	18.3	5	138.0	15.4	28	145.5	23.8	8	136.7	27.5
Total Pop.*	354	130.4	18.4	351	118.1	18.9	363	130.5	19.5	327	117.1	21.9
Diastolic												
18-24	39	74.4	10.8	61	69.5	7.9	28	70.8	11.9	25	70.8	6.6
25-34	82	76.4	10.2	80	73.8	9.8	39	78.9	12.8	70	75.4	11.6
35-44	75	83.1	10.6	86	77.3	11.4	54	82.4	11.4	52	78.2	10.3
45-54	69	83.3	9.9	54	83.4	12.3	61	85.3	11.1	50	83.9	14.8
55-64	50	82.2	11.8	39	84.5	14.9	61	85.4	12.0	73	87.9	16.4
65-74	21	82.6	14.0	26	86.7	14.9	92	85.5	14.0	49	85.5	14.2
75+	18	81.8	11.8	5	87.3	6.0	28	80.8	11.1	8	73.1	16.5
Total Pop.*	354	80.9	11.3	351	78.9	12.6	363	82.1	13.0	327	79.8	14.4

* Total Population means are age-sex adjusted to the total sample size.

TABLE 43 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS (mm. Hg) OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURE AMONG WHITE PERSONS 18-75+ YEARS OF AGE HAVING BEEN DETERMINED OBESE BY SKINFOLD READINGS: WEST DUNDEE AND McHENRY, ILLINOIS, 1967-77

Blood Pressure	West Dundee						McHenry					
	Male			Female			Male			Female		
Age (Years)	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation
Systolic												
18-24	10	127.0	11.2	8	101.0	4.4	5	118.4	4.3	10	110.1	11.9
25-34	8	131.2	16.2	29	104.3	13.5	10	128.8	14.5	27	109.2	10.7
35-44	13	118.5	6.7	30	118.2	21.5	13	129.5	11.6	18	115.6	19.2
45-54	12	127.8	13.3	24	121.6	13.9	7	134.4	14.4	29	121.6	21.2
55-64	6	133.4	31.4	24	137.4	24.7	6	132.6	11.2	39	128.5	20.8
65-74	2	113.0	18.4	13	149.7	26.7	8	144.0	13.1	40	135.2	15.7
75+	0	--	--	9	150.7	11.9	1	107.3	--	10	147.7	12.7
Total Pop.*	51	126.1	15.7	137	126.6	24.6	50	130.6	14.0	173	123.0	20.3
Diastolic												
18-24	10	77.6	10.8	8	67.1	10.9	5	77.5	10.2	10	75.6	6.9
25-34	8	89.3	9.2	29	74.1	13.1	10	85.6	13.2	27	79.8	11.4
35-44	13	83.2	3.0	30	82.5	16.3	13	86.5	7.8	18	86.2	12.6
45-54	12	87.7	8.8	24	84.6	10.2	7	91.6	11.8	29	86.2	14.7
55-64	6	90.6	19.3	24	90.2	16.5	6	89.8	18.5	39	88.9	15.8
65-74	2	65.7	8.0	13	92.2	14.3	8	92.9	7.7	40	88.3	17.2
75+	0	--	--	9	89.1	14.6	1	71.3	--	10	84.7	13.9
Total Pop.*	51	84.3	11.2	137	84.1	15.6	50	87.2	11.8	173	85.2	14.8

* Total population means are age-sex adjusted to the total sample size.

TABLE 44 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS (mm. Hg) OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURE AMONG WHITE PERSONS 18-75+ YEARS OF AGE, HAVING BEEN DETERMINED NONOBESE BY SKINFOLD READINGS: WEST DUNDEE AND McHENRY, ILLINOIS, 1976-77

Blood Pressure	West Dundee						McHenry					
	Male			Female			Male			Female		
Age (Years)	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation
Systolic												
18-24	67	122.8	14.2	104	104.9	10.5	49	120.4	13.1	43	105.2	10.2
25-34	114	123.4	12.9	118	107.1	12.0	67	121.2	12.1	84	105.5	12.1
35-44	79	124.7	17.7	103	109.8	12.0	61	122.9	15.7	70	110.2	16.4
45-54	77	127.9	16.7	66	121.2	18.8	67	129.2	15.4	60	113.8	16.7
55-64	63	131.2	20.6	51	123.7	17.8	71	135.9	18.2	97	129.9	23.0
65-74	27	141.1	19.1	47	134.9	18.2	120	140.5	21.5	97	136.6	22.2
75+	28	149.9	20.4	40	151.8	25.4	46	145.6	21.5	46	145.7	22.8
Total Pop. *	455	130.2	18.1	529	119.0	20.5	481	129.7	19.7	497	118.5	23.6
Diastolic												
18-24	67	73.4	10.7	104	70.3	7.7	49	70.9	10.8	43	72.3	6.6
25-34	114	76.0	10.3	118	73.2	9.1	67	77.3	9.5	84	72.9	10.4
35-44	79	82.7	11.2	103	75.8	9.2	61	81.7	11.5	70	77.9	10.7
45-54	77	83.4	11.6	66	83.2	11.5	67	85.2	11.2	60	79.2	13.3
55-64	63	82.0	12.4	51	81.6	13.4	71	85.8	12.2	97	86.3	14.9
65-74	27	83.3	13.4	47	84.1	14.3	120	85.3	13.5	97	85.9	13.7
75+	28	80.4	10.1	40	87.8	14.7	46	81.9	12.5	46	83.1	17.1
Total Pop.*	455	80.2	11.8	529	78.4	29.3	481	81.2	12.7	497	79.0	14.0

* Total population means are age-sex adjusted to the total sample size.

TABLE 45 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS OF PULSE RATE PER MINUTE AMONG WHITE PERSONS 18-75+ YEARS OF AGE: WEST DUNDEE AND McHENRY, ILLINOIS, 1976-77

Age (Years)	West Dundee						McHenry					
	Male			Female			Male			Female		
	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation
18-24	77	76.2	10.3	114	75.6	9.7	54	74.3	10.4	53	77.7	10.8
25-34	122	75.7	11.1	147	77.9	9.7	77	77.1	12.2	111	78.7	10.3
35-44	92	79.5	9.8	133	79.2	11.5	74	78.5	13.2	88	78.8	12.1
45-54	89	78.7	11.2	91	76.5	10.7	75	79.6	12.8	90	76.9	8.7
55-64	69	74.2	11.8	75	74.3	10.8	76	75.9	11.4	136	75.1	10.8
65-74	29	74.8	11.2	59	75.2	12.3	127	74.1	11.1	137	75.6	11.5
75+	28	76.9	12.2	48	74.5	10.6	47	73.8	10.9	55	74.3	9.3
Total Pop.*	506	76.6	11.0	667	76.4	10.7	530	76.5	11.9	670	77.0	10.7

* Total population means are age-sex adjusted to the total sample size.

pressure medication and have lived greater than 10 years or 10 years and less in the community, (4) males and females who do not have definite hypertension, nor are taking high blood pressure medication, and have lived greater than 10 years or 10 years and less in the community, (5) males and females who do not have definite hypertension nor are currently taking high blood pressure medication, (6) males and females with definite hypertension or taking blood pressure medication, (7) males and females on high blood pressure medication, (8) males and females no longer taking high blood pressure medication, (9) males and females who do not have water softeners, (10) males and females who do not have water softeners and have lived greater than 10 years or 10 years and less in the community, (11) males and females who do not have water softeners and are not taking blood pressure medication, (12) males and females who do not have water softeners, are not taking blood pressure medication, and have lived greater than 10 years or 10 years and less in the community, (13) males and females who do not have water softeners, who do not have definite hypertension, nor are taking high blood pressure medication, (14) males and females who do not have water softeners, who do not have definite hypertension, are not taking high blood pressure medication, and have lived greater than 10 years or 10 years and less in the community, (15) males and females who have never smoked, or have smoked sometime during their lifetime, and (17) obese and nonobese males and females.

When systolic and diastolic blood pressures for males and females from West Dundee were compared to blood pressures for males and females from McHenry for all of the above categories, significant differences ($P < 0.05$) unless stated otherwise were found as follows:

1. Systolic total population ($P = 0.06$) and age-specific means for females living 10 years or less in the community (Table 23).

2. Systolic total population and age-specific ($P = 0.06$) means for females who are not taking blood pressure medication and have lived 10 years or less in the community (Table 25).

3. Systolic total population means for females who do not have definite hypertension, are not taking high blood pressure medication, and have lived greater than 10 years or 10 years and less in the community (Table 26 and 27). The age-specific mean systolic blood pressures were only significantly different between West Dundee and McHenry females living 10 years and less in the community.

4. Systolic total population ($P = 0.06$) and age-specific means for males who do not have water softeners and have lived greater than 10 years in the community (Table 33).

5. Systolic total population ($P = 0.05$) and age-specific ($P = 0.08$) means for males who do not have water softeners, are not taking high blood pressure medication, and have lived greater than 10 years in the community (Table 36). Also, systolic age-specific ($P = 0.08$) means for females having the same corrections made as for the males above with the exception of living in the community for 10 years and less (Table 37).

6. Systolic total population and age-specific means for males who do not have water softeners, who do not have definite hypertension, are not taking high blood pressure medication, and have lived greater than 10 years in the community (Table 39). Also, systolic age-specific means for females having the same corrections made as for the males above with the exception of living in the community for 10 years and less (Table 40).

In addition to making comparisons for blood pressure differences between communities and time of residence, a comparison was made for possible blood pressure differences within the study communities with respect to time of residence. The only significant difference found was for both systolic and diastolic total population and age-specific mean blood pressures among males who have lived in West Dundee greater than 10 years compared to those males who have lived in West Dundee for 10 years or less (Table 21).

Further analysis indicates that there are no significant differences for the proportion of males and females from West Dundee who have definite hypertension or are taking blood pressure medication when compared to McHenry males and females under the same conditions. More West Dundee males were found to take blood pressure medication for their hypertension than McHenry males. Finally, no significant differences were found in West Dundee male and female pulse rates when compared to the pulse rates of males and females in McHenry.

Although there were some significant differences found in the blood pressure data between the high barium and the low barium communities, the data is inconclusive mainly because of inconsistencies in the findings. For instance, significant difference in female systolic blood pressures occurred for those females residing in the community for 10 years or less, while no significant difference was found for females residing greater than 10 years in the community. This same finding was also shown for females living 10 years or less in the community and not on high blood pressure medication. Sometimes a significant difference would be found for males living greater than 10 years in the community and for females living 10 years or less in the community. Finally, since over 100 analyses were run to test for significant difference in the total population and age-specific mean systolic blood pressures, and over 100 tests for differences in these means for diastolic blood pressures, some of the significant differences happened by chance alone. It must be pointed out that all of the findings could not have happened by chance alone, and that significant differences between West Dundee and McHenry residents were found for male systolic blood pressures when corrections were made for water softeners, and time of residence; water softeners, time of residence, and blood pressure medication; and water softeners, time of residence, blood pressure medication, and hypertension. Also, female systolic blood pressures were found significantly different between these high barium and low barium populations when corrections were made for time of residence, hypertension, and blood pressure medication.

C. Prevalence rates of hypertension, stroke, heart disease, diabetes and kidney disease (Tables 46-53).

All age-specific prevalence rates for males and females were analyzed using the signed rank test for age-specific rates and the weighted Z test for total population rates. The prevalence rates for definite and borderline hypertension in males and females from West Dundee were not significantly different from the prevalence rates for these two types of hypertension in the males and females of McHenry (Tables 46 and 47). In addition, the prevalence rates for both males and females in West Dundee and McHenry with definite hypertension were slightly lower when compared with those males and females in the United States as a whole (Table 48) (68). The above comparisons might not be totally meaningful because those individuals on blood pressure medication were not considered. However, when those males and females from West Dundee taking blood pressure medication or having definite hypertension were compared to the same type of male and female populations in McHenry (Table 49), no significant differences were found. Although no significant differences were found, these prevalence rates were now slightly higher for both communities when compared with those males and females in the United States as a whole (Table 48) (68). Also, five of the seven age grouping had higher prevalence rates for West Dundee males in comparison to McHenry males (Table 49).

The prevalence rates for stroke, heart disease, diabetes and kidney disease in males and females from West Dundee were not significantly different from the prevalence rates for these respective diseases in males and females of McHenry (Tables 50-53). In Table 50, more males in West Dundee in age-groups 45 years old and older have higher rates of stroke than their counterparts in McHenry. Therefore, an additional statistical test (Mantel-Haenszel) (59) was run to see if there was a difference in actual numbers of stroke between these West Dundee and McHenry males. No significant differences were found.

Refusals

West Dundee had 165 households (20.1%) refusing to participate in the study, while McHenry had 181 households (21.4%) that refused. As mentioned previously (Section 5), an attempt was made to bring the refusals into the study. However, it was felt that the health data obtained from the refusals should be treated separately from the data collected from those who volunteered initially to prevent biasing the data in any manner. As it turned out, there were not enough refusals, who agreed to participate when asked a second time, to warrant analysis of the data separately. Ten households totaling 18 people from West Dundee, and 28 households totaling 46 people from McHenry agreed to participate, after initially refusing. The blood pressure data from this population sample is presented in Table 54.

Water Sample Analysis

A water sample was collected and analyzed for each household surveyed to see if the concentration of various metals in specific household water was different from the community's water treatment plant metal analysis.

TABLE 46 AGE-SPECIFIC PREVALENCE RATES OF DEFINITE HYPERTENSION FOR PERSONS 18-75+ YEARS OF AGE: WEST DUNDEE AND McHENRY, ILLINOIS, 1976-77

Definite Hyper-tension+ and Age (Years)	West Dundee				McHenry			
	Male		Female		Male		Female	
	Pop. Size	Rate/100 Pop.	Pop. Size	Rate/100 Pop.	Pop. Size	Rate/100 Pop.	Pop. Size	Rate/100 Pop.
18-24	77	5.2	114	0.0	54	3.7	53	0.0
25-34	122	7.4	147	2.7	77	5.2	111	1.8
35-44	92	12.0	133	6.0	74	13.5	88	11.4
45-54	89	15.7	91	17.6	75	18.7	90	13.3
55-64	69	14.5	75	20.0	77	23.4	136	27.9
65-74	29	31.0	60	21.7	128	28.9	137	29.2
75+	28	21.4	49	44.9	47	38.3	56	32.1
Total Pop.*	506	14.8	669	13.7	532	17.0	671	15.3

TABLE 47 AGE-SPECIFIC PREVALENCE OF BORDERLINE HYPERTENSION FOR PERSONS 18-75+ YEARS OF AGE: WEST DUNDEE AND McHENRY ILLINOIS, 1976-77

Border-line Hyper-tension++ and Age (Years)	West Dundee				McHenry			
	Male		Female		Male		Female	
	Pop. Size	Rate/100 Pop.	Pop. Size	Rate/100 Pop.	Pop. Size	Rate/100 Pop.	Pop. Size	Rate/100 Pop.
18-24	77	13.0	114	0.0	54	11.1	53	0.0
25-34	122	14.8	147	2.7	77	13.0	111	8.1
35-44	92	10.9	133	6.8	74	13.5	88	11.4
45-54	89	19.1	91	15.4	75	17.3	90	12.2
55-64	69	20.3	75	17.3	77	22.1	136	16.2
65-74	29	24.1	60	25.0	128	24.2	137	22.6
75+	28	53.6	49	32.7	47	25.5	56	39.3
Total Pop.*	506	19.6	669	12.7	532	17.3	671	14.0

+ Systolic blood pressure of at least 160 mm. Hg or diastolic blood pressure of at least 95 mm. Hg.

++ Systolic blood pressure 160 mm. Hg and below 95 mm. Hg. diastolic blood pressure, but not simultaneously below 140 and 90 mm. Hg.

* Total population **rates** are age-sex adjusted to the total sample size.

TABLE 48 AGE-SPECIFIC PREVALENCE RATES OF DEFINITE HYPERTENSION AMONG WHITE PERSONS 18-74 YEARS OF AGE: UNITED STATES,1971-74(68)

Definite Hypertension + and Age (years)	Male Rate/100 Population	Female Rate/100 Population
18-24	4.9	1.4
25-34	8.2	3.7
35-44	17.3	10.1
45-54	25.8	18.9
55-64	31.1	31.7
65-74	35.3	42.3
Total	18.5	15.7

+ Systolic blood pressure of at least 160 mm. Hg or diastolic blood pressure of at least 95 mm. Hg.

TABLE 49 AGE-SPECIFIC PREVALENCE RATES FOR PERSONS 18-75+ YEARS OF AGE WITH DEFINITE HYPERTENSION OR WHO ARE CURRENTLY TAKING HIGH BLOOD PRESSURE MEDICATION: WEST DUNDEE AND McHENRY, ILLINOIS 1976-77

Hyper-+ tension or on medication and age (Years)	West Dundee				McHenry			
	Male		Female		Male		Female	
	Total No.	Rate/100 Population	Total No.	Rate/100 Population	Total No.	Rate/100 Population	Total No.	Rate/100 Population
18-24	77	6.5	114	0.9	54	3.7	53	0.0
25-34	122	7.4	147	2.7	77	5.2	111	2.7
35-44	92	18.5	133	9.8	74	14.9	88	12.5
45-54	89	30.3	91	29.7	75	28.0	90	18.9
55-64	69	29.0	75	36.0	77	31.2	136	40.4
65-74	29	48.3	60	46.7	128	40.6	137	48.2
75+	28	35.7	49	61.2	47	46.8	56	44.6
Total Pop.*	506	24.1	669	23.7	532	22.3	671	22.1

+ Systolic Blood Pressure of at least 160 mm. Hg or Diastolic Blood Pressure of at least 95 mm. Hg.

* Total population rates are age-sex adjusted to the total sample size.

TABLE 50 AGE-SPECIFIC PREVALENCE RATES OF WHITE PERSONS 18-75+ YEARS OF AGE, WHO HAVE HAD A STROKE DIAGNOSED BY A PHYSICIAN: WEST DUNDEE AND McHENRY, ILLINOIS, 1976-77

Stroke and Age (years)	West Dundee				McHenry			
	Male		Female		Male		Female	
	Pop. Size	Rate/100 Pop.	Pop. Size	Rate/100 Pop.	Pop. Size	Rate/100 Pop.	Pop. Size	Rate/100 Pop.
18-24	77	0.0	114	0.0	54	1.9	53	0.0
25-34	122	0.0	147	0.0	77	0.0	111	0.0
35-44	92	0.0	133	1.5	74	0.0	88	0.0
45-54	89	0.0	91	1.1	75	1.3	90	1.1
55-64	69	2.9	75	2.7	77	6.5	136	3.7
65-74	29	13.8	60	8.5	128	5.5	137	8.0
75+	28	17.9	49	4.1	47	6.4	56	8.9
Total Pop.*	506	3.8	669	2.4	532	2.7	671	2.6

TABLE 51 AGE-SPECIFIC PREVALENCE RATES OF WHITE PERSONS 18-75+ YEARS OF AGE, WHO HAVE HAD HEART DISEASE DIAGNOSED BY A PHYSICIAN: WEST DUNDEE AND McHENRY, ILLINOIS, 1976-77

Heart Disease and Age (Years)	West Dundee				McHenry			
	Male		Female		Male		Female	
	Pop. Size	Rate/100 Pop.	Pop. Size	Rate/100 Pop.	Pop. Size	Rate/100 Pop.	Pop. Size	Rate/100 Pop.
18-24	77	0.0	114	0.0	54	0.0	53	0.0
25-34	122	0.0	147	0.0	77	0.0	111	0.0
35-44	92	3.3	133	1.5	74	0.0	88	2.3
45-54	89	3.4	91	4.4	75	6.7	90	4.4
55-64	69	4.3	75	4.0	77	13.0	136	9.6
65-74	29	13.8	60	5.0	128	15.6	137	8.0
75+	28	21.4	49	8.2	47	14.9	56	16.1
Total Pop.*	506	5.3	669	2.8	532	6.3	671	4.9

* Total population rates are age-sex adjusted to the total sample size.

TABLE 52 AGE-SPECIFIC PREVALENCE RATES OF WHITE PERSONS 18-75+ YEARS OF AGE, WHO HAVE HAD DIABETES DIAGNOSED BY A PHYSICIAN: WEST DUNDEE AND McHENRY, ILLINOIS, 1976-77

Diabetes and Age (Years)	West Dundee				McHenry			
	Male		Female		Male		Female	
	Pop. Size	Rate/100 Pop.	Pop. Size	Rate/100 Pop.	Pop. Size	Rate/100 Pop.	Pop. Size	Rate/100 Pop.
18-24	77	1.3	114	0.0	54	1.9	53	3.8
25-34	122	1.6	147	6.1	77	1.3	111	4.5
35-44	92	1.1	133	3.0	74	12.2	88	5.7
45-54	89	5.6	91	5.5	75	6.7	90	4.4
55-64	69	11.6	75	8.0	77	14.3	136	7.4
65-74	29	10.3	60	8.3	128	20.3	137	9.5
75+	28	21.4	49	8.2	47	21.3	56	17.9
Total Pop.*	506	6.3	669	5.1	532	10.1	671	6.9

TABLE 53 AGE-SPECIFIC PREVALENCE RATES OF WHITE PERSONS 18-75+ YEARS OF AGE, WHO HAVE HAD KIDNEY DISEASE DIAGNOSED BY A PHYSICIAN: WEST DUNDEE AND McHENRY, ILLINOIS, 1976-77

Kidney Disease and Age (Years)	West Dundee				McHenry			
	Male		Female		Male		Female	
	Pop. Size	Rate/100 Pop.	Pop. Size	Rate/100 Pop.	Pop. Size	Rate/100 Pop.	Pop. Size	Rate/100 Pop.
18-24	77	5.2	114	21.1	54	1.9	53	9.4
25-34	122	7.4	147	21.8	77	9.1	111	16.2
35-44	92	4.3	133	9.0	74	6.8	88	13.6
45-54	89	13.5	91	16.5	75	10.7	90	20.0
55-64	69	7.2	75	10.7	77	10.4	136	8.8
65-74	29	6.9	60	10.0	128	10.9	137	18.2
75+	28	3.7	49	14.3	47	14.9	56	12.5
Total Pop.*	506	7.3	669	14.9	532	8.9	671	14.3

* Total population rates are age-sex adjusted to the total sample size.

TABLE 54 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS (mm.Hg) OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURE AMONG WHITE PERSONS 18-75+ YEARS OF AGE WHO INITIALLY REFUSED TO PARTICIPATE BUT VOLUNTEERED TO BE PART OF THE STUDY WHEN ASKED A SECOND TIME: WEST DUNDEE AND McHENRY, ILLINOIS, 1976-77

Blood Pressure Age (Years)	West Dundee						McHenry					
	Male			Female			Male			Female		
	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation	Pop. Size	Mean	Standard Deviation
Systolic												
18-24	1	117.7	0.0	0	-	-	1	140.0	0.0	0	-	-
25-34	2	127.3	11.3	2	102.0	5.7	3	123.6	3.0	4	103.3	10.4
35-44	1	122.0	0.0	2	103.5	4.0	0	-	-	3	130.4	13.7
45-54	0	-	-	2	133.0	13.7	5	132.6	16.8	2	132.5	1.2
55-64	3	135.3	22.7	2	159.0	17.4	6	136.3	17.6	5	122.5	21.3
65-74	2	140.3	9.0	1	104.7	0.0	4	144.0	15.4	9	139.1	18.5
75+	0	-	-	0	-	-	2	139.0	27.3	2	174.3	3.3
Total Pop.	9	131.2	14.8	9	122.2	25.7	21	135.5	15.8	25	131.3	23.3
Diastolic												
18-24	1	62.0	0.0	0	-	-	1	93.3	0.0	0	-	-
25-34	2	90.0	21.7	2	72.7	3.8	3	77.3	4.1	4	67.3	10.4
35-44	1	76.7	0.0	2	68.3	2.4	0	-	-	3	97.1	17.3
45-54	0	-	-	2	84.3	7.1	5	91.0	13.4	2	96.2	8.7
55-64	3	79.3	6.6	2	97.7	14.6	6	88.1	5.2	5	82.8	16.3
65-74	2	80.0	2.8	1	68.0	0.0	4	94.7	19.8	9	92.1	17.8
75+	0	-	-	0	-	-	2	73.8	1.6	2	93.2	2.1
Total Pop.	9	79.6	11.7	9	70.3	13.5	21	87.4	12.3	25	87.3	17.1

Also, household water samples were analyzed to make sure that some toxic metal, like cadmium or lead, was not present to bias interpretation of the data.

Results of West Dundee and McHenry water treatment plant sample analysis for 12 metals are shown in Table 55. The major differences found between the metal concentrations in the two water supplies occurred with barium and strontium. The mean concentration for barium and strontium in West Dundee treatment plant water exceeded that of McHenry treatment plant water by approximately 75 and seven-fold respectively.

In addition, 12 samples were collected on a biweekly basis for six months and analyzed by Purdue University (under contract to Health Effects Research Laboratory, US. EPA) using proton induced x-ray emission (Table 56). The samples were analyzed for 81 elements to detect if there were any other differences between the two water supplies. Major differences from the above analyses were as follows: (1) an eight and six-fold increase in rubidium and potassium in West Dundee treatment plant water when comapred to McHenry treatment plant water respectively (a mean of 0.00560 mg/l vs. 0.00067 mg/l rubidium and 8.51 vs. 1.44 mg/l potassium). (2) a 19 fold increase in iron was found in McHenry treatment plant water when compared to the plant at West Dundee (a mean of 0.632 mg/l vs. 0.033 mg/l iron). (3) a mean of 14.9 mg/l sulfur was found in McHenry treatment plant water, while sulfur in West Dundee treatment plant water was below the limit of detection (< 0.1 mg/l). Although there were some differences between the two water supplies, barium was the only substance analyzed that exceeded the National Interim Primary Drinking Water Regulations (3). Also, no possible health effects from consumption of rubidium, potassium, iron, or sulfur from drinking water were even suggested or discussed in these drinking water regulations (3), in Water Quality Criteria 1972 (70), or in Quality Criteria for Water (71).

Results of West Dundee and McHenry household water sample analysis are shown in Tables 57-63. These results are depicted in seven tables to show the impact home water softeners have on altering the metal concentrations of treatment plant water.

Tables 57-59 are directed toward question number 21 in the questionnaire (Appendix A) which asks, "Is there a water softening unit for your home water supply?" Table 57 presents the water sample analysis for 12 metals in all households. When Table 57 was compared with Table 55 (Water Treatment Plant Samples), the major differences noted, particularly in McHenry, were a decrease in calcium and magnesium concentrations and an increase in sodium. These differences in calcium, magnesium and sodium concentrations became more pronounced when only households that answered yes to the water softening question were compared to the same water parameters of their respective treatment plants (Tables 58 and 55). In addition to altering the concentrations of calcium, magnesium and sodium, home water softeners removed barium and strontium from West Dundee water (Tables 58 and 55). Also, the copper concentrations in the softened water houses showed an increase over those of the treatment plants (Tables 58 and 55). This increase in copper might be due to the more corrosive softened water leaching copper out of home plumbing systems. When the results of water sample analysis from households

TABLE 55 ANALYSIS OF WATER TREATMENT PLANT SAMPLES USING ATOMIC ABSORPTION FROM WEST DUNDEE AND McHENRY, ILLINOIS, 1976-77

	West Dundee Treatment Plant*		McHenry Treament Plant**	
METAL	Mean+	Standard Deviation	Mean+	Standard Deviation
Barium	6.78	1.15	0.09	0.13
Cadmium	<0.01	--	<0.01	--
Calcium	53.26	7.99	85.50	8.50
Chromium (Total)	<0.01	--	<0.01	--
Copper	0.01	.02	0.01	0.01
Lead	<0.05	--	<0.05	--
Magnesium	22.90	1.40	41.50	2.81
Mercury	<0.0001	--	<0.0001	--
Nickel	<0.10	--	<0.10	--
Sodium	18.58	0.98	19.58	1.80
Strontium	3.12	0.36	0.46	0.08
Zinc	0.09	0.14	0.01	0.02

* 19 Samples
** 20 Samples
+ Mean values with (<) are below instrumental detection limits

TABLE 56 PROTON INDUCED X-RAY EMISSION ANALYSIS (ug/l) FOR ELEMENTS FOUND IN WATER SAMPLES COLLECTED OVER A SIX MONTH PERIOD (OCTOBER, 1976-MARCH, 1977) FROM THE WATER TREATMENT PLANTS IN WEST DUNDEE AND McHENRY, ILLINOIS

Element	West Dundee			McHenry		
	# Samples	Mean	Standard Deviation	# Samples	Mean	Standard Deviation
Arsenic	5*	1.6	1.2	9*	1.9	2.4
Barium	12	7307.5	858.4	11	104.1	15.5
Bromine	12	16.0	2.8	11	29.5	3.3
Calcium	12	55178.8	8502.3	11	84234.3	9863.1
Chlorine	11*	2986.3	3437.7	9*	6009.0	4872.5
Copper	12	10.0	9.1	11	16.3	8.7
Iodine	6*	7.6	2.7	4*	4.98	0.9
Iron	12	33.3	6.9	11	632.3	724.0
Lead	12	4.9	1.9	9*	2.1	1.3
Maganese	12	26.1	6.3	11	73.1	57.9
Nickel	10*	0.5	0.4	8*	0.8	0.5
Potassium	12	8510.4	1386.0	11	1437.5	335.7
Rubidium	12	5.6	4.3	2*	0.7	0.3
Sodium	12	20716.7	560.6	11	21354.5	2443.5
Strontium	12	2937.0	236.1	11	503.3	61.0
Sulfur	0*	--	--	11	14906.1	5666.8
Zinc	12	36.6	16.6	11	40.9	36.1

* Only those collected samples above the detection limits of the instrument are included in this table.

TABLE 57 ANALYSIS OF WATER SAMPLES, FOR 12 METALS IN mg/l, FROM HOUSEHOLDS WITH AND WITHOUT WATER SOFTENERS, PLUS THOSE HOUSEHOLDS NOT KNOWING WHETHER OR NOT A SOFTENER IS USED: WEST DUNDEE AND McHENRY, ILLINOIS, 1976-77

	West Dundee *		McHenry **	
Metal	Mean+	Standard Deviation	Mean +	Standard Deviation
Barium	6.40	2.45	0.09	0.11
Cadmium	<0.01	--	<0.01	--
Calcium	47.31	18.39	54.25	35.57
Chromium (total)	<0.01	--	<0.01	--
Copper	0.03	0.04	0.25	0.32
Lead	<0.05	--	<0.05	--
Magnesium	19.53	7.53	30.32	20.62
Mercury	<0.0001	--	<0.0001	--
Nickel	<0.10	--	<0.10	--
Sodium	32.06	36.27	64.42	75.06
Strontium	2.73	1.05	0.31	0.27
Zinc	0.09	0.18	0.10	0.25

* 631 Samples
** 643 Samples
+ Mean values with (<) are below instrumental detection limits.

TABLE 58 ANALYSIS OF WATER SAMPLES, FOR 12 METALS IN mg/l FROM HOUSEHOLDS WITH WATER SOFTENERS: WEST DUNDEE AND McHENRY, ILLINOIS, 1976-77

Metal	West Dundee *		McHenry **	
	Mean+	Standard Deviation	Mean+	Standard Deviation
Barium	4.32	3.39	0.08	0.10
Cadmium	<0.01	--	<0.01	--
Calcium	33.38	26.39	43.64	37.92
Chromium (total)	<0.01	--	<0.01	--
Copper	0.03	0.04	0.28	0.34
Lead	<0.05	--	<0.05	--
Magnesium	13.98	11.03	24.93	21.93
Mercury	<0.0001	--	<0.0001	--
Nickel	<0.10	--	<0.10	--
Sodium	62.315	53.29	86.51	81.49
Strontium	1.86	1.48	0.25	0.26
Zinc	0.10	0.19	0.09	0.25

* 189 Samples
** 426 Samples
+ Mean values with (<) are below instrumental detection limits.

without water softeners were compared to their respective treatment plants, it was noted that the concentrations for the 12 metals were very similar (Tables 59 and 55).

Since many people do not properly maintain their home water softener, there could be some masking of the true impact that water softeners have on changing the concentrations of specific metals. As a consequence, households with low and high concentrations of sodium were compared with one another (Tables 60-63). Tables 60 and 61 compare the analysis of household water samples that had concentrations of sodium equal to or less than 25 mg/l with water samples exceeding 25 mg/l sodium. A concentration of 25 mg/l sodium was chosen because neither water treatment plant exceeded this concentration. Therefore, it was assumed that a sodium concentration greater than 25 mg/l was due to the home water softener. In Table 60, with sodium concentrations ≤ 25 mg/l, the concentrations of the 12 metals from both communities were quite similar when compared to their respective treatment plant (Table 55). However, when the treatment plant data was compared with households that had greater than 25 mg/l in their water (Table 61) changes in concentration were observed for several of the metals. As expected, water softeners were removing the divalent cations and exchanging them with sodium, a monovalent cation. Both communities showed a decrease in calcium and magnesium, and an increase in sodium. Also, West Dundee had a marked reduction in barium and strontium. In fact, the barium concentration was reduced five-fold, leaving a mean concentration just above the water quality standard of 1.0 mg/l.

Since there are differences in the functioning and maintenance of home water softeners, a comparison was made between households with 100 mg/l or less sodium in their water and those with a greater than 100 mg/l sodium (Tables 62 and 63). As noted in Table 62, (households with sodium concentrations ≤ 100 mg/l), the metal concentrations closely resembled those of their respective treatment plant. However, those households exceeding 100 mg/l sodium in their water (Table 63) showed a decrease in the barium, calcium, magnesium and strontium concentrations to negligible amounts when compared to the treatment plant concentrations of these metals (Table 55). It can be noted from the above tables that households with water softeners contributing to greater than 100 mg/l sodium in their water were able to easily reduce the barium levels below the MCL of 1 0 mg/l.

Althoush household water data were analyzed in many different ways, only one metal found in West Dundee household water and two metals found in McHenry water exceeded either the U.S. (3) or Illinois drinking water regulations (4). In West Dundee, barium exceeded the 1.0 mg/l standard in 555 of the 631 household water samples analyzed. Water softeners in 76 households were able to reduce the barium levels below the standard. In McHenry, the lead standard for water (0.05 mg/l) was exceeded in 3 households out of 643 surveyed. Of those three households exceeding the lead standard, two of them had a water softener. All three households exceeding the lead standard had newly installed copper plumbing. The lead was probably coming from solder in the plumbing joints that had not been thoroughly washed out of the system. Although there is not a specific U.S. drinking water regulation for copper, Illinois has a copper drinking water standard of 1.0 mg/l (maximum allowable twelve-month average concentration). This limit is based on ones

TABLE 59 ANALYSIS OF WATER SAMPLES, FOR 12 METALS IN mg/l, FROM HOUSEHOLDS WITHOUT WATER SOFTENERS: WEST DUNDEE AND McHENRY, ILLINOIS, 1976-77

	West Dundee *		McHenry **	
Metal	Mean +	Standard Deviation	Mean +	Standard Deviation
Barium	7.35	0.85	0.12	0.12
Cadmium	<0.01	--	<0.01	--
Calcium	53.54	7.26	76.75	12.28
Chromium (total)	<0.01	--	<0.01	--
Copper	0.03	0.03	0.19	0.26
Lead	<0.05	--	<0.05	--
Magnesium	22.10	2.84	41.72	10.53
Mercury	<0.0001	--	<0.0001	--
Nickel	<0.10	--	<0.10	--
Sodium	18.36	5.12	17.20	16.11
Strontium	3.12	0.34	0.44	0.20
Zinc	0.09	0.17	0.10	0.23

* 390 Samples
** 206 Samples
+ Mean values with (<) are below instrumental detection limits.

TABLE 60 ANALYSIS OF WATER SAMPLES, FOR 12 METALS IN mg/l, FROM HOUSEHOLDS WITH SODIUM CONCENTRATIONS $\leq$ 25 mg/l: WEST DUNDEE AND McHENRY, ILLINOIS, 1976-77

	West Dundee *		McHenry **	
Metal	Mean +	Standard Deviation	Mean+	Standard Deviation
Barium	7.32	0.84	0.12	0.12
Cadmium	<0.01	--	<0.01	--
Calcium	54.11	6.54	77.57	11.57
Chromium (total)	<0.01	--	<0.01	--
Copper	0.03	0.03	0.23	0.31
Lead	<0.05	--	<0.05	--
Magnesium	22.22	2.69	42.27	9.85
Mercury	<0.0001	--	<0.0001	--
Nickel	<0.10	--	<0.10	--
Sodium	18.11	0.82	15.81	5.85
Strontium	3.13	0.30	0.44	0.21
Zinc	0.08	0.17	0.10	0.23

* 545 Samples

** 420 Samples

+ Mean values with (<) are below instrumental detection limits.

TABLE 61 ANALYSIS OF WATER SAMPLES, FOR 12 METALS IN mg/l, FROM HOUSEHOLDS WITH SODIUM CONCENTRATIONS > 25 mg/l: WEST DUNDEE AND McHENRY, ILLINOIS, 1976-77

Metal	West Dundee *		McHenry **	
	Mean+	Standard Deviation	Mean +	Standard Deviation
Barium	1.29	2.13	0.05	0.07
Cadmium	<0.01	--	<0.01	--
Calcium	9.39	16.81	13.08	25.13
Chromium (total)	<0.01	--	<0.01	--
Copper	0.05	0.06	0.29	0.34
Lead	<0.05	--	<0.05	--
Magnesium	4.57	8.16	9.10	17.42
Mercury	<0.0001	--	<0.0001	--
Nickel	<0.10	--	<0.10	--
Sodium	109.56	38.55	151.49	62.48
Strontium	0.54	1.00	0.08	0.14
Zinc	0.11	0.22	0.10	0.27

* 101 Samples
** 235 Samples
+ Mean values with (<) are below instrumental detection limits.

TABLE 62 ANALYSIS OF WATER SAMPLES, FOR 12 METALS IN mg/l, FROM HOUSEHOLDS WITH SODIUM CONCENTRATIONS ≤ 100 mg/l: WEST DUNDEE AND McHENRY, ILLINOIS, 1976-77

Metal	West Dundee *		McHenry **	
	Mean+	Standard Deviation	Mean+	Standard Deviation
Barium	7.21	1.05	0.12	0.11
Cadmium	<0.01	--	<0.01	--
Calcium	53.38	7.76	75.45	15.11
Chromium (total)	<0.01	--	<0.01	--
Copper	0.03	0.03	0.23	0.30
Lead	<0.05	--	<0.05	--
Magnesium	22.07	2.94	42.00	10.89
Mercury	<0.001	--	<0.0001	--
Nickel	<0.10	--	<0.10	--
Sodium	19.15	6.46	18.92	12.45
Strontium	3.09	0.39	0.43	0.21
Zinc	0.08	0.17	0.10	0.22

* 568 Samples
** 466 Samples
+ Mean values with (<) are below instrumental detection limits.

TABLE 63 ANALYSIS OF WATER SAMPLES, FOR 12 METALS IN mg/l, FROM HOUSEHOLDS WITH SODIUM CONCENTRATIONS > 100 mg/l: WEST DUNDEE AND McHENRY, ILLINOIS, 1976-77

Metal	West Dundee *		McHenry **	
	Mean +	Standard Deviation	Mean+	Standard Deviation
Barium	0.27	0.32	0.03	0.05
Cadmium	<0.01	--	<0.01	--
Calcium	1.55	6.87	2.62	7.65
Chromium (total)	<0.01	--	<0.01	--
Copper	0.05	0.06	0.30	0.35
Lead	<0.05	--	<0.05	--
Magnesium	0.42	0.83	1.69	4.58
Mercury	<0.0001	--	<0.0001	--
Nickel	<0.10	--	<0.10	--
Sodium	128.92	12.37	176.86	38.27
Strontium	0.05	0.08	0.02	0.06
Zinc	0.10	0.23	0.09	0.29

* 78 Samples
** 189 Samples
+ Mean values with (<) are below instrumental detection limits.

ability to taste it rather than on a health hazard (70). Copper exceeded 1.0 mg/l in 22 of 643 households surveyed in McHenry. Seventeen of the 22 households replied in the questionnaire that they had a water softener.

Drinking Water Sodium Concentrations And Blood Pressure Levels

Age-specific systolic and diastolic blood pressures for males and females from McHenry, exposed to diverse sodium concentrations in their drinking water, were analyzed using the Wilcoxon Signed-Rank Test (66) (Tables 64-67). Only males and females from McHenry were used to determine whether or not increased sodium levels had an effect on blood pressure because barium in the West Dundee water supply might also effect blood pressure and possibly mask any health effects of elevated sodium levels. A drinking water concentration of ≤ 25 mg/l sodium was used as the baseline for comparison because that was the level found at the McHenry treatment plant (Tables 55 and 56). Any sodium concentration greater than 25 mg/l could be attributed to home water softeners. Therefore, male and female blood pressures that were exposed to ≤ 25 mg/l sodium were compared to those male and female blood pressures that were exposed to > 25 mg/l, 25-99 mg/l, ≤ 100 mg/l, >100 mg/l, 100-200 mg/l and > 200 mg/l sodium respectively. The only significant difference found for any of the above comparisons was between male systolic and diastolic blood pressures when exposed to greater than 200 mg/l sodium in comparison to those males who were exposed to 25 mg/l or less sodium (Tables 64 and 65). Since the sample size for those exposed to greater than 200 mg/l sodium is small and all of the other comparisons were not significant, there is little relevance to this finding. It can be concluded that elevated sodium concentrations in McHenry drinking water had little effect on the blood pressures of McHenry residents.

Drinking Water Sodium Concentrations And Prevalence Rates Of Heart Disease, Hypertension, Stroke, And Kidney Disease

It was mentioned previously that softened water may be associated with cardiovascular disease (52,53,54,55). Therefore, persons exposed to greater than 100 mg/l sodium from home water softeners were compared to those persons exposed to 100 mg/l or less sodium in their water to ascertain if there were differences in heart disease, hypertension, stroke, and kidney disease. The Mantel-Haenszel Chi Square Statistics (59) with adjustment for sex, age (18-44 and 45 75+), and town (West Dundee and McHenry) was used to decide whether or not there was a relationship between the above diseases and sodium concentration. Age was adjusted for only two groupings because further refinement into numerous groupings would have resulted in too few people with a particular disease in each group. The Mantel-Haenszel Chi Square Statis tics (59) for the above diseases were not significant (Tables 68-75). This finding indicates that there were no significant differences between the high and low sodium groups with respect to heart disease, hypertension, stroke, and kidney disease.

TABLE 64 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS (mm.Hg) OF SYSTOLIC BLOOD PRESSURE AMONG WHITE MALES 18-75+ YEARS OF AGE, FROM McHENRY, ILLINOIS (1976-77), WHO ARE EXPOSED TO DIVERSE SODIUM CONCENTRATIONS IN THEIR DRINKING WATER

	Sodium Concentration (mg/1) in Household Samples						
Age	≤ 25 mg/1 Mean (Standard Deviation) Pop. Size	> 25 mg/1 Mean (Standard Deviation) Pop. Size	25-99 mg/1 Mean (Standard Deviation) Pop. Size	≤ 100 mg/1 Mean (Standard Deviation) Pop. Size	> 100 mg/1 Mean (Standard Deviation) Pop. Size	100-200 mg/1 Mean (Standard Deviation) Pop. Size	> 200 mg/1 Mean (Standard Deviation) Pop. Size
18-24	119.4 (12.3) 35	123.5 (12.4) 17	133.0 (6.1) 4	120.8 (12.5) 39	120.6 (12.5) 13	120.6 (12.5) 13	- - 0
25-34	122.6 (12.9) 46	121.5 (12.3) 31	118.0 (6.4) 6	122.1 (12.3) 52	122.4 (13.3) 25	122.9 (15.1) 19	120.9 (10.3) 6
35-44	124.5 (13.8) 44	122.7 (17.0) 29	126.6 (24.1) 6	125.0 (15.1) 49	121.4 (15.1) 24	120.4 (15.9) 20	126.3 (10.3) 4
45-54	127.4 (16.5) 47	133.8 (12.2) 27	138.6 (11.5) 6	128.6 (16.1) 54	132.7 (12.6) 20	131.9 (13.3) 18	136.0 (2.9) 3
55-64	133.6 (18.0) 44	137.0 (17.5) 30	146.5 (24.2) 5	134.9 (18.8) 49	135.1 (15.8) 25	133.8 (17.1) 20	140.3 (8.4) 5
65-74	141.8 (19.7) 85	138.5 (23.6) 43	130.1 (16.2) 9	140.7 (19.6) 94	140.7 (24.9) 34	138.2 (22.2) 32	181.7 (40.1) 2
75+	148.4 (21.6) 35	136.0 (20.3) 11	141.2 (10.1) 2	148.1 (21.1) 37	134.9 (22.1) 9	131.1 (20.4) 8	165.0 (0.0) 1

TABLE 65 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS (mm.Hg) OF DIASTOLIC BLOOD PRESSURE AMONG WHITE MALES 18-75+ YEARS OF AGE, FROM McHENRY, ILLINOIS (1976-77), WHO ARE EXPOSED TO DIVERSE SODIUM CONCENTRATIONS IN THEIR DRINKING WATER

	Sodium Concentration (mg/1) in Household Samples						
Age	≤ 25 mg/1 Mean (Standard Deviation) Pop. Size	> 25 mg/1 Mean (Standard Deviation) Pop. Size	25-99 mg/1 Mean (Standard Deviation) Pop. Size	≤ 100 mg/1 Mean (Standard Deviation) Pop. Size	> 100 mg/1 Mean (Standard Deviation) Pop. Size	100-200 mg/1 Mean (Standard Deviation) Pop. Size	> 200 mg/1 Mean (Standard Deviation) Pop. Size
18-24	71.3 (11.2) 35	72.6 (11.6) 17	74.4 (16.4) 4	71.7 (11.6) 39	72.1 (9.7) 13	72.1 (9.7) 13	- - 0
25-34	79.1 (9.1) 46	77.7 (12.0) 31	73.1 (9.4) 6	78.4 (9.2) 52	78.7 (12.5) 25	78.6 (13.4 19	79.3 (9.9) 6
35-44	82.1 (9.1) 44	83.3 (12.0) 29	81.8 (23.7) 6	82.5 (12.1) 49	82.7 (8.5) 24	82.3 (8.2) 20	84.9 (11.2) 4
45-54	85.3 (12.3) 47	87.0 (9.5) 27	90.0 (5.0) 6	85.9 (11.7) 54	85.8 (10.5) 20	86.6 (11.1) 18	83.1 (3.4) 3
55-64	84.0 (11.5) 44	89.1 (13.8) 30	90.7 (7.3) 5	84.6 (11.2) 49	88.8 (14.9) 25	87.6 (15.6) 20	93.9 (11.2) 5
65-74	85.4 (12.0) 85	87.0 (15.4) 43	80.8 (7.9) 9	85.0 (11.8) 94	88.6 (16.6) 34	86.6 (14.1) 32	120.7 (25.5) 2
75+	83.7 (13.2) 35	75.9 (7.6) 11	80.7 (2.8) 2	83.5 (12.9) 37	74.8 (8.0) 9	73.3 (7.2) 8	86.7 (0.0) 1

TABLE 66 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS (mm.Hg) OF SYSTOLIC BLOOD PRESSURE AMONG WHITE FEMALES 18-75+ YEARS OF AGE, FROM McHENRY, ILLINOIS (1976-77), WHO ARE EXPOSED TO DIVERSE SODIUM CONCENTRATIONS IN THEIR DRINKING WATER

	Sodium Concentration (mg/1) in Household Samples						
Age	≤ 25 mg/1 Mean (Standard Deviation) Pop. Size	> 25 mg/1 Mean (Standard Deviation) Pop. Size	25-99 mg/1 Mean (Standard Deviation) Pop. Size	≤ 100 mg/1 Mean (Standard Deviation) Pop. Size	> 100 mg/1 Mean (Standard Deviation) Pop. Size	100-200 mg/1 Mean (Standard Deviation) Pop. Size	> 200 mg/1 Mean (Standard Deviation) Pop. Size
18-24	104.2 (10.8) 38	110.9 (8.5) 15	106.2 (7.8) 2	104.3 (10.6) 40	111.7 (8.7) 13	111.7 (10.7) 10	111.8 (1.9) 3
25-34	106.8 (12.3) 64	105.5 (11.1) 44	104.5 (9.2) 11	106.4 (11.8) 75	105.9 (11.8) 33	107.2 (11.7) 28	98.8 (10.5) 5
35-44	112.3 (17.3) 56	109.5 (16.6) 32	110.5 (20.4) 5	112.4 (17.5) 60	108.9 (16.0) 28	109.8 (16.8) 24	103.8 (10.0) 4
45-54	116.6 (19.2) 64	115.7 (17.2) 25	118.9 (24.5) 7	116.8 (19.4) 72	114.5 (14.6) 17	116.2 (14.1) 16	101.0 (4.2) 2
55-64	130.1 (19.2) 81	128.6 (26.9) 49	124.7 (21.7) 14	129.3 (19.5) 95	130.1 (28.8) 35	132.2 (30.8) 29	120.2 (14.4) 6
65-74	136.3 (19.2) 92	136.6 (22.9) 44	140.9 (25.8) 6	136.6 (19.5) 98	135.9 (22.7) 38	135.9 (23.0) 37	136.0 (0.0) 1
75+	144.0 (20.5) 36	149.9 (24.0) 18	157.4 (33.9) 4	145.4 (22.0) 40	147.7 (21.5) 14	145.7 (18.7) 12	159.7 (42.9) 2

TABLE 67 AGE-SPECIFIC MEANS AND STANDARD DEVIATIONS (mm.Hg) OF DIASTOLIC BLOOD PRESSURE AMONG WHITE FEMALES 18-75+ YEARS OF AGE, FROM McHENRY, ILLINOIS (1976-77), WHO ARE EXPOSED TO DIVERSE SODIUM CONCENTRATIONS IN THEIR DRINKING WATER

	Sodium Concentration (mg/1) in Household Samples						
Age	≤ 25 mg/1 Mean (Standard Deviation) Pop. Size	> 25 mg/1 Mean (Standard Deviation) Pop. Size	25-99 mg/1 Mean (Standard Deviation) Pop. Size	≤ 100 mg/1 Mean (Standard Deviation) Pop. Size	> 100 mg/1 Mean (Standard Deviation) Pop. Size	100-200 mg/1 Mean (Standard Deviation) Pop. Size	> 200 mg/1 Mean (Standard Deviation) Pop. Size
18-24	72.3 (7.0) 38	74.7 (6.1) 15	71.7 (1.4) 2	72.2 (6.8) 40	75.2 (6.4) 13	74.7 (7.2) 10	76.4 (3.4) 3
25-34	73.8 (10.4) 64	75.1 (11.8) 44	72.1 (10.7) 11	73.6 (10.4) 75	76.2 (12.1) 33	76.7 (11.7) 28	73.5 (15.1) 5
35-44	81.1 (12.6) 56	77.1 (9.0) 32	78.0 (8.3) 5	81.0 (12.3) 60	76.8 (9.1) 28	77.6 (9.4) 24	72.2 (4.6) 4
45-54	82.3 (14.9) 64	80.0 (11.5) 25	84.1 (11.2) 7	82.3 (14.4) 72	78.7 (11.8) 17	79.1 (12.0) 16	73.0 (1.4) 2
55-64	86.1 (14.2) 81	87.7 (16.8) 49	87.7 (19.3) 14	86.4 (15.0) 95	87.7 (16.0) 35	88.6 (16.9) 29	83.6 (11.0) 6
65-74	86.7 (14.7) 92	86.4 (14.7) 44	94.7 (22.1) 6	87.2 (15.2) 98	85.0 (13.1) 38	85.2 (13.3) 37	80.0 (0.0) 1
75+	81.6 (16.0) 36	86.3 (16.7) 18	87.7 (27.5) 4	82.2 (17) 40	85.9 (13.8) 14	84.6 (13.5) 12	94.0 (17.9) 2

TABLE 68 AGE-SPECIFIC PREVALENCE RATES OF WHITE MALES 18-75+ YEARS OF AGE WHO HAVE HAD HEART DISEASE DIAGNOSED BY A PHYSICIAN AND ARE EXPOSED TO VARYING SODIUM CONCENTRATIONS IN THEIR DRINKING WATER: WEST DUNDEE AND McHENRY, ILLINOIS, 1976-77

Heart Disease and age (years)	West Dundee				McHenry			
	Sodium ≤100mg/l		Sodium >100mg/l		Sodium ≤100mg/l		Sodium >100mg/l	
	Male		Male		Male		Male	
	Total No.	Rate/100 Population	Total No.	Rate/100 Population	Total No.	Rate/100 Population	Total No.	Rate/100 Population
18-24	73	0.0	4	0.0	40	0.0	13	0.0
25-34	108	0.0	13	0.0	52	0.0	25	0.0
35-44	77	3.9	13	0.0	49	0.0	24	0.0
45-54	72	4.2	15	0.0	54	9.3	21	0.0
55-64	58	5.2	9	0.0	49	14.3	24	8.3
65-74	28	14.3	1	0.0	94	13.8	34	20.6
75+	26	19.2	2	50.0	37	18.9	9	0.0
Total Pop.*	442	5.5	57	2.9	375	6.9	150	4.8

TABLE 69 AGE-SPECIFIC PREVALENCE RATES OF WHITE FEMALES 18-75+ YEARS OF AGE WHO HAVE HAD HEART DISEASE DIAGNOSED BY A PHYSICIAN AND ARE EXPOSED TO VARYING SODIUM CONCENTRATIONS IN THEIR DRINKING WATER: WEST DUNDEE AND McHENRY, ILLINOIS, 1976-77

Heart Disease and age (years)	West Dundee				McHenry			
	Sodium ≤100mg/l		Sodium >100mg/l		Sodium ≤100mg/l		Sodium >100mg/l	
	Female		Female		Female		Female	
	Total No.	Rate/100 Population	Total No.	Rate/100 Population	Total No.	Rate/100 Population	Total No.	Rate/100 Population
18-24	104	0.0	7	0.0	40	0.0	13	0.0
25-34	121	0.0	25	0.0	75	0.0	34	0.0
35-44	106	1.9	24	0.0	60	3.3	28	0.0
45-54	82	4.9	8	0.0	73	4.1	17	5.9
55-64	63	4.8	11	0.0	95	6.3	36	13.9
65-74	55	5.5	3	0.0	98	4.1	39	17.9
75+	48	8.3	1	0.0	40	17.5	14	7.1
Total Pop.*	579	3.2	79	0.0	481	4.0	181	7.7

* Total population rates are age-adjusted to the total sample size.

TABLE 70 AGE-SPECIFIC PREVALENCE RATES OF WHITE MALES 18-75+ YEARS OF AGE WHO HAVE DEFINITE HYPERTENSION+ AND ARE EXPOSED TO VARYING SODIUM CONCENTRATIONS IN THEIR DRINKING WATER: WEST DUNDEE AND McHENRY, ILLINOIS, 1976-77

Definite Hypertension+ and age (years)	West Dundee				McHenry			
	Sodium ≤100mg/1		Sodium >100mg/1		Sodium ≤100mg/1		Sodium >100mg/1	
	Male		Male		Male		Male	
	Total No.	Rate/100 Population	Total No.	Rate/100 Population	Total No.	Rate/100 Population	Total No.	Rate/100 Population
18-24	73	5.5	4	0.0	40	5.0	13	0.0
25-34	108	6.5	13	15.4	52	3.8	25	8.0
35-44	77	13.0	13	7.7	49	12.2	24	16.7
45-54	72	18.1	15	6.7	54	18.5	21	19.0
55-64	58	15.5	9	11.1	49	24.5	24	16.7
65-74	28	32.1	1	0.0	94	24.5	34	41.2
75+	26	23.1	2	0.0	37	43.2	9	22.2
Total Pop.*	442	15.4	57	7.2	375	16.3	150	18.4

TABLE 71 AGE-SPECIFIC PREVALENCE RATES OF WHITE FEMALES 18-75+ YEARS OF AGE WHO HAVE DEFINITE HYPERTENSION+ AND ARE EXPOSED TO VARYING SODIUM CONCENTRATIONS IN THEIR DRINKING WATER: WEST DUNDEE AND McHENRY, ILLINOIS, 1976-77

Definite Hypertension+ and age (years)	West Dundee				McHenry			
	Sodium ≤100mg/1		Sodium >100mg/1		Sodium ≤100mg/1		Sodium >100mg/1	
	Female		Female		Female		Female	
	Total No.	Rate/100 Population	Total No.	Rate/100 Population	Total No.	Rate/100 Population	Total No.	Rate/100 Population
18-24	104	0.0	7	0.0	40	0.0	13	0.0
25-34	121	3.3	25	0.0	75	1.3	34	2.9
35-44	106	5.7	24	8.3	60	15.0	28	3.6
45-54	82	17.1	8	12.5	73	15.1	17	5.9
55-64	63	22.2	11	0.0	95	21.1	36	44.4
65-74	55	18.2	3	33.3	98	29.6	39	28.2
75+	48	45.8	1	0.0	40	32.5	14	28.6
Total Pop.*	579	13.7	79	8.1	481	14.9	181	16.2

+ Systolic blood pressure of at least 160 mm.Hg or diastolic blood pressure of at least 95 mm.Hg.

* Total population rates are age-adjusted to the total sample size.

TABLE 72 AGE-SPECIFIC PREVALENCE RATES OF WHITE MALES 18-75+ YEARS OF AGE WHO HAVE HAD STROKE DIAGNOSED BY A PHYSICIAN AND ARE EXPOSED TO VARYING SODIUM CONCENTRATIONS IN THEIR DRINKING WATER: WEST DUNDEE AND MCHENRY, ILLINOIS, 1976-77

Stroke and age (years)	West Dundee				McHenry			
	Sodium ≤100mg/l		Sodium >100mg/l		Sodium ≤100mg/l		Sodium >100mg/l	
	Male		Male		Male		Male	
	Total No.	Rate/100 Population	Total No.	Rate/100 Population	Total No.	Rate/100 Population	Total No.	Rate/100 Population
18-24	73	0.0	4	0.0	40	2.5	13	0.0
25-34	108	0.0	13	0.0	52	0.0	25	0.0
35-44	77	0.0	13	0.0	49	0.0	24	0.0
45-54	72	0.0	15	0.0	54	1.9	21	0.0
55-64	58	3.4	9	0.0	49	4.1	24	12.5
65-74	28	14.3	1	0.0	94	5.3	34	5.9
75+	26	19.2	2	0.0	37	5.4	9	11.1
Total Pop.*	442	4.0	57	0.0	375	2.0	150	4.0

TABLE 73 AGE-SPECIFIC PREVALENCE RATES OF WHITE FEMALES 18-75+ YEARS OF AGE WHO HAVE HAD STROKE DIAGNOSED BY A PHYSICIAN AND ARE EXPOSED TO VARYING SODIUM CONCENTRATIONS IN THEIR DRINKING WATER: WEST DUNDEE AND McHENRY, ILLINOIS 1976-77

Stroke and age (years)	West Dundee				McHenry			
	Sodium ≤100mg/l		Sodium >100mg/l		Sodium ≤100mg/l		Sodium >100mg/l	
	Female		Female		Female		Female	
	Total No.	Rate/100 Population	Total No.	Rate/100 Population	Total No.	Rate/100 Population	Total No.	Rate/100 Population
18-24	104	0.0	7	0.0	40	0.0	13	0.0
25-34	121	0.0	25	0.0	75	0.0	34	0.0
35-44	106	1.9	24	0.0	60	0.0	28	0.0
45-54	82	1.2	8	0.0	73	1.4	17	0.0
55-64	63	3.2	11	0.0	95	3.2	36	5.6
65-74	55	9.1	3	0.0	98	7.1	39	10.3
75+	48	4.2	1	0.0	40	10.0	14	0.0
Total Pop.*	579	2.6	79	0.0	481	2.5	181	3.3

* Total population rates are age-adjusted to the total sample size.

TABLE 74 AGE-SPECIFIC PREVALENCE RATES OF WHITE MALES 18-75+ YEARS OF AGE WHO HAVE HAD KIDNEY DISEASE DIAGNOSED BY A PHYSICIAN AND ARE EXPOSED TO VARYING SODIUM CONCENTRATIONS IN THEIR DRINKING WATER: WEST DUNDEE AND McHENRY, ILLINOIS 1976-77

Kidney Disease and age (years)	West Dundee				McHenry			
	Sodium ≤100mg/l		Sodium >100mg/l		Sodium ≤100mg/l		Sodium >100mg/l	
	Male		Male		Male		Male	
	Total No.	Rate/100 Population	Total No.	Rate/100 Population	Total NO.	Rate/100 Population	Total No.	Rate/100 Population
18-24	73	5.5	4	0.0	40	2.5	13	0.0
25-34	108	7.4	13	7.7	52	11.5	25	4.0
35-44	77	3.9	13	7.7	49	6.1	24	8.3
45-54	72	15.3	15	6.7	54	11.1	21	9.5
55-64	58	6.9	9	0.0	49	8.2	24	16.7
65-74	28	7.1	1	0.0	94	11.7	34	8.8
75+	26	3.8	2	0.0	37	13.5	9	22.2
Total Pop.*	442	7.3	57	3.9	375	9.2	150	9.2

TABLE 75 AGE-SPECIFIED PREVALENCE RATES OF WHITE FEMALES 18-75+ YEARS OF AGE WHO HAVE HAD KIDNEY DISEASE DIAGNOSED BY A PHYSICIAN AND ARE EXPOSED TO VARYING SODIUM CONCENTRATIONS IN THEIR DRINKING WATER: WEST DUNDEE AND McHenry, ILLINOIS 1976-77

Kidney Disease and age (years)	West Dundee				McHenry			
	Sodium ≤100mg/l		Sodium >100mg/l		Sodium ≤100mg/l		Sodium >100mg/l	
	Female		Female		Female		Female	
	Total No.	Rate/100 Population	Total NO.	Rate/100 Population	Total No.	Rate/100 Population	Total No.	Rate/100 Population
18-24	104	22.1	7	14.3	40	5.0	13	23.1
25-34	121	21.5	25	24.0	75	21.3	34	5.9
35-44	106	10.4	24	4.2	60	15.0	28	10.7
45-54	82	14.6	8	37.5	73	20.5	17	17.6
55-64	63	12.7	11	0.0	95	8.4	36	11.1
65-74	55	10.9	3	0.0	98	20.4	39	12.8
75+	48	14.6	1	0.0	40	10.0	14	21.4
Total Pop.*	579	15.4	79	10.8	481	15.6	181	12.3

* Total population rates are age-adjusted to the total sample size.

REFERENCES

1. Advisory Report on Health Effects of Barium in Water. IIEQ Document No. EHRC-12, Illinois Institute for Environmental Quality, 1974.

2. **Gilkeson**, R., Specht, S., Cartwright, K. and Griffin, R. Geologic Studies to Identify the Source for High Levels of Radium and Barium in Illinois Groundwater Supplies. Illinois State Geological Survey, 1978.

3. U.S. Environmental Protection Agency. National Interim Primary Drinking Water Regulations. EPA-570/9-76-003, 1977.

4. Illinois Pollution Control Board Rules and Regulations. Chapter 6. Public Water Supplies, November 22, 1974.

5. Roza, D. and Berman, L.B. The pathophysiology of barium: Hypokalemic and cardiovascular effects. J. Pharmacol. Exp. Thera., 177: 433-439, 1971.

6. Diengott, D., Roza, O., Levy, N. and Muammar, S. Hypokalemia in barium poisoning. Lancet, 2:343-344, 1964.

7. Goodman, L.S. and Gilman, A. The Pharmacological Basis of Therapeutics. New York, The Macmillan Company, 1970.

8. Sollman, T.A. Manual of Pharmacology. Philadelphia, W.B. Saunders Company, 1953.

9. Tardiff, R.G., Robinson, M. and Ulmer, N.S. Subchronic oral toxicity of $BaCl_2$ in rat. Toxicol. Appl. Pharmacol., 99: (In press).

10. Schroeder, H.A. and Mitchener, M. Life-term studies in rats: Effects of aluminum, barium, beryllium and tungsten. J. Nutr., 105:421-427, 1975.

11. Domanski, T., Liniecki, J. and Witkowska, D. Kinetics of calcium, strontium, barium, and radium in rats. In:Delayed Effects of Bone-Seeking Radionuclides, ed. by C.W. Mays, W.S.S. Jee, R.D. Lloyd, B.J. Stover, J.H. Dougherty and G.N. Taylor. University of Utah Press, pp. 79-84, 1969.

12. Bauer, G.C.H., Carlsson, A. and Lindquist, B. A comparative study on the metabolism of ^{140}Ba and ^{45}Ca in rats. Biochem. J., 63:535-542, 1956.

13. Bauer, G.C.H. Carlsson, A. and Lindquist, B. Metabolism of ^{140}BA in man. Acta Orthop. Scand., 26:241-254, 1957.

14. Sowden, E.M. Trace elements in human tissue. 3. Strontium and barium in non-skeletal tissues. Biochem. J., 70:712-715, 1958.

15. Schroeder, H.A., Tipton, I.H. and Nason, A.P. Trace metals in man: Strontium and barium. J. Chron. Dis., 25:491-517, 1972.

16. Harrison, G.E., Carr, T.E.F. and Sutton, A. Plasma concentration and excretion of calcium-47, strontium-85, barium-133 and radium-223 following successive doses to a healthy man. Nature, 209:526-527, 1966.

17. Harrison, G.E., Carr, T.E.F. and Sutton, A. Distribution of radioactive calcium, strontium, barium and radium following intravenous injection into a healthy man. Int. J. Radiat. Biol., 13:235-247, 1967.

18. Clary, J.J. and Tardiff, R.G. The absorption, distribution, and excretion of orally administered $^{133}BaCl_2$ in weanling male rats. Paper presented at the Thirteenth Annual Meeting of the Society of Toxicology, March 10-14, Washington, D.C., 1974.

19. Bligh, T.H. and Taylor, D.M. Comparative studies of the metabolism of strontium and barium in the rat. Biochem. J., 87:612-618, 1963.

20. Ellsasser, J.C., Farnham, J.E. and Marshall, J.H. Comparative kinetics and autoradiography of ^{45}Ca and ^{133}Ba in ten-year-old Beagle dogs. J. Bone Joint Surg., 51:1397-1412, 1969.

21. Taylor, D.M., Bligh, P.H. and Duggan, M.H. The absorption of calcium, strontium, barium and radium from the gastrointestinal tract of the rat. Biochem. J., 83:25-29, 1962.

22. Bligh, P.H. and Taylor, D.M. Comparative studies of the metabolism of strontium and barium in the rat. Biochem. J., 87:612-618, 1963.

23. Tipton, I.H., Stewart, P.L. and Dickson, J. Patterns of elemental excretion in long term balance studies. Health Physics, 16:455-462, 1969.

24. Smith, P.K., Winkler, A.W. and Hoff, H.E. Cardiovascular changes following the intravenous administration of barium chloride. J. Pharmacol. Exp. Thera., 68:113-122, 1940.

25. Mascher, D. Electrical and mechanical responses in ventricular muscle fibers during barium perfusion. Pflugers Arch., 342:325-346, 1973.

26. Slavicek, J. Effect of Ba on contractility of the isolated right rat ventricle. Substitution of NaCl for chlorine or hypertonic sucrose. Physiol. Bohem., 21:189-199, 1972.

27. Lehmkuhl, D. and Sperelakis, N. Ba depolarization of cultured heart cells. Fed. Proc., 24:137, 1965.

28. Kleinfeld, M., Stein, E. and Tionaytis, C. Effects of barium on mature and embryonic heart cells. *Circ. Res.*, 18:484-491, 1966.

29. Sperelakis, N. and Lehmkuhl, D. Ionic interconversion of pacemaker and nonpacemaker cultured chick heart cells. *J. Gen. Physiol.*, 49:867-895, 1966.

30. LaVan, D.W., Haskin, M.E., Wohl, G.T. and Bellet, S. Cardiac changes produced during routine roentgen study of the lower bowel by barium enema. *Circulation*, 26:747, 1962.

31. Berman, C.Z., Jacobs, M.G. and Bernstein, A. Hazards of the barium enema examination as studied by electrocardiographic telemetry: Preliminary report. *J. Amer. Geri. Soc.*, 13:672-686, 1965.

32. Gibbs, G., Lueker, R.D., Baxley, W.A. and Wolfel, D.A. Cardiac arrhythmia associated with barium enema. *Rocky Mt. Med. J.*, 69:63-66, 1972.

33. Higgins, C., Roeske, W., Karliner, J., Berk, R. and O'Roeske, W., Karliner, J., Berk, R. and O'Rourke, R. Incidence of significant arrhythmias in elderly patients during barium enema. *Circulation*, 49 (Suppl. III):230,1974.

34. Roeskie, W.R., Higgins, C., Karliner, J.S., Berk, R.N. and O'Rourke, R.A. Incidence of arrhythmias and ST-segment changes in elderly patients during barium enema studies. *Amer. Heart J.*, 90:688-694, 1975.

35. Douglas, W.W. Stimulus-secretion coupling: The concept and clues from chromaffin and other cells. *Brit. J. Pharmacol.*, 34:451-474, 1968.

36. Rubin, R.P. The role of calcium in the release of neurotransmitter substances and hormones. *Pharmacol. Rev.*, 22:389-428, 1970.

37. Douglas, W.W. The role of calcium in stimulus-secretion coupling. In: *Stimulus-Secretion Coupling in the Gastrointestinal Tract*, ed. by R.M. Case and H. Goebell. Baltimore, University Park Press, pp. 17-29, 1976.

38. Douglas, W.W. and Rubin, R.P. Stimulant action of barium on the adrenal medulla. *Nature*, 203:305-307, 1964.

39. Douglas, W.W. and Rubin, R.P. The effects of alkaline earths and other divalent cations on adrenal medullary secretion. *J. Physiol.*, 175:231-241, 1964.

40. Boullin, D.J. Effect of divalent ions on release of ^{3}H-noradrenaline by sympathetic nerve stimulation. *J. Physiol.*, 183:76p, 1965.

41. Boullin, D.J. The action of extracellular cations on the release of the sympathetic transmitter from peripheral nerves. J. Physiol., 189:85-89, 1967.

42. Kirpekar, S.M. and Misu, Y. Release of noradrenaline by splenic nerve stimulation and its dependence on calcium. J. Physiol., 188:219-234, 1967.

43. Engelman, K., Portnoy, B. and Sjoerdsma, A. Plasma catecholamine concentrations in patients with hypertension. Circ. Res., 27 (Suppl. I): 141-145, 1970.

44. Louis, W.J., Doyle, A.E. and Anavekar, S. Plasma norepinephrine levels in essential hypertension. N. Engl. J. Med., 288:599-601, 1973.

45. deChamplin, J., Farley, L., Cousineau, D. and VanAmeringen, M. Circulation catecholamine levels in human and experimental hypertension. Circ. Res., 38:109-114, 1976.

46. Elwood, P.C., Abernethy, M. and Morton, M. Mortality in adults and trace elements in water. Lancet, 2:1470-1472, 1974.

47. Schroeder, H.A. and Kraemer, L.A. Cardiovascular mortality, municipal water, and corrosion. Arch. Environ. Health, 28:303-311, 1974.

48. U.S. Environmental Protection Agency. Quality Criteria for Water. EPA-440/9-76-023, 1976.

49. Stokinger, H.E. and Woodward, R.L. Toxicologic methods for establishing drinking water standards. Jour. Amer. Water Works Assn., 50:515-529, 1958.

50. Documentation of the Threshold Limit Values. 3rd Ed. Cincinnati, American Conference of Government Industrial Hygienists, 1971.

51. International Classification of Diseases, Adopted. 8th Revision. U.S. Dept. Health, Education and Welfare. Public Health Service, Pub. No. 1693, 1968.

52. Schroeder, H.A. and Kraemer, L.A. Cardiovascular mortality, municipal water and corrosion. Arch. Environ. Health, 28:303-311, 1974.

53. Crawford, R., M.J. and Morris, J.N. Changes in water hardness and local death rates. Lancet., 2:327-329, 1971.

54. Gardner, M.J. and Crawford, M.D. Patterns of mortality in middle and early old age in the country Boroughs of England and Wales. Brit. J. Prev. Soc. Med., 23:133-140, 1969.

55. Biorck, G., Bostrom, H. and Winstrom, A. On relationship between water hardness and death rates in cardiovascular diseases. ACTA Med. Scand., 239-252, 1965.

56. Illinois Department of Public Health,: *Vital Statistics Illinois* 1971-75, Springfield, Illinois, 1972-76.

57. Illinois Environmental Protection Agency Public Water Supplies, *Cook County to Will County* (film reel Number 16283), Springfield, Illinois April 17, 1975.

58. *1970 Census of Population*. General population characteristics. Illinois Bureau of the Census. U.S. Dept. of Commerce. pc (1) - B15.

59. Fleiss, J. *Statistical Methods for Rates and Proportions*, John Wiley and Sons, New York, 1973.

60. McCaughan, D. Comparison of an electronic blood pressure apparatus with a mercury manometer. *J. for the Advancement of Medical Instrumentation*. 11-13, November, 1966.

61. Brozek, J. Physique and nutritional status of adult men. *Human Biology*., 28:124-140, 1956.

62. Nie, N.H., Hull, C.H., Jenkins, J.G., Steinbrenner, K., Bent, D.H. *Statistical Package for the Social Sciences*, 2nd Ed., McGraw-Hill 1975.

63. Frazier, R.P., Jr., Lang, M.C., Miller, J.A. Murray, J.F., and Westerhold, A.F. *Manual of Laboratory Methods*. State of Illinois Environmental Protection Agency. Springfield, Illinois, 1973.

64. Ronan, R. Simultaneous analysis of liquid samples for medals by inductively coupled argon plasma atomic-emission spectroscopy (ICAP-AES). *United States Environmental Protection Agency, Region V, Central Regional Laboratory*, 1819 West Pershing Road, Chicago, 1975.

65. El-Wady, A., Miller, R. and Carter, M. Automated method for the determination of total and inorganic mercury in water and wastewater samples. *Analytical Chem*., 48 (1):110-116, 1976.

66. Dixon, W.J. and Massey, F.J., Jr. *Introduction to Statistical Analysis*, McGraw-Hill Book Co., New York, 1969.

67. National Center for Health Statistics: Persons hospitalized by number of episodes and days in a year, United States, 1972. *Vital and Health Statistics*. Series 10-No. 116. DHEW Publication No. (HRA) 77-1544. U.S. Government Printing Office, August, 1977.

68. National Center for Health Statistics: Blood pressure of persons 65-74 years of age in the United States. *Vital and Health Statistics Advance Data*. DHEW, No. 1, October 18, 1976.

69. Mayer, J. Obesity: Diagnosis. *Postgrad. Med*., 25:469-475, 1959.

70. Water Quality Criteria 1972. National Academy of Science, National Academy of Engineering. U.S. Government Printing Office, Washington, D.C., 1974

71. Quality Criteria for Water. U.S. Environmental Protection Agency, Washington, D.C., July, 1976.

APPENDIX A. HOUSEHOLD LISTING AND SURVEY OF MINERALS AND HEALTH

☐☐☐☐
1 2 3 4
Identification Number

Household Listing

Address: ______________________________
Street No. City State Zip

Phone: ________________

Please tell me the names of all the persons 18 years old and over living at home at this time, beginning with the head of the household? (Enter on line 1 below) Is there anyone else? What is their relationship to him/her? (Repeat until all persons in household are listed)

PRINT NAMES IN BLOCK CAPITALS

Line No.	Last Name	First Name	Middle Name or Initial	Relation to Head	Date Completed
1				Head	
2					
3					
4					
5					
6					
7					
8					
9					

☐ Refusal (Please specify) ______________________________

☐ Other (Please specify) ______________________________

Survey of Minerals and Health

☐☐☐☐☐ Identification Number 1 2 3 4 5	1-5/ Identification Number
	7/ Interviewer Number
I would like to ask you some questions about your health.	
1. During the past year, that is between _____, 1975 and _____, 1976, about how many times have you visited a doctor's office or clinic or had a doctor to your home because of illness?	
______ time(s)	8,9/
2. During the past year, that is between _____, 1975 and _____, 1976, about how many days were you away from work or unable to carry out your usual activities because of an illness, disability, or injury?	
______ day(s)	10-12/

3.a. Were you a patient in a hospital at any time in the past year?

No 2

Yes 1 — 13/

b. What was the total number of days you have spent in a hospital during the past year?

______day(s) — 14-16/

c. For what reasons were you hospitalized? (Circle as many as apply).

Pregnancy	1	
Surgery	2	
Injury	3	
Illness	4	
Other	5 (Specify) ____________________	17/
	____________________	18/
		19/

4. Have you ever had your blood pressure taken?

Yes	No	DK	
1	2	9	20/

(For "No", Skip to Q. 6)

Now I would like to take a reading of your blood pressure. (Reading 1. Please record on Q. 32)

5.a. Have you ever been told by a doctor that you had high blood pressure?

No 2 DK 9 Yes 1 21/

b. About how many years ago were you first told that you had high blood pressure?

_____years 22,23/

c. Have you ever taken high blood pressure medicine that a doctor prescribed for you?

No 2 DK 9 Yes 1 24/

d. What was the name of the medicine(s)?

________________________________ 25/

________________________________ 26/

e. Are you still taking medicine(s) for high blood pressure?

DK 9 Yes 1 No 2 27/

f. How many years ago did you last take medicine(s) for high blood pressure?

_____years 28,29/

g. Why did you stop?

____

____

________________________ 30/

MEN SKIP TO Q. 6

h. Were you pregnant when the doctor first told you that you had high blood pressure?

No 2 DK 9 Yes 1 31/

i. Other than when you were pregnant, have you ever been told that you had high blood pressure?

No 2 DK 9 Yes 1 32/

6.a. Did a doctor ever tell you that you had a heart attack, coronary, myocardial infarction, coronary thrombosis or coronary occlusion?

No	DK	Yes	
2	9	1	33/

b. How many years ago was this?

_____ years 34,35/

7.a. Have you ever had severe pain or discomfort in your chest following exercise or physical exertion?

No	Yes	
2	1	36/

b. Did you see a doctor about it?

No	Yes	
2	1	37/

c. What did he say it was?

_____

_____

_____ 38/

d. Did he give you medicine(s) for it?

No	Yes	
2	1	39/

e. What is the name of the medicine(s)?

_____ 40/

_____ 41/

8. a. Have you ever had an EKG or electrocardiogram taken?

No DK Yes
2 9 1 — 42/

b. Were you told that it was

normal 1
or
abnormal? 2 — 43/

9. a. Have you ever been told of any other heart trouble such as rheumatic fever or a heart murmur?

No DK Yes
2 9 1 — 44/

b. What did the doctor say it was?

______________________________ 45/

c. How many years ago were you told?

______ years 46,47/

d. Have you ever taken medicine(s) for it?

No DK Yes
2 9 1 — 48/

e. What is the name of medicine(s)?

______________________________ 49/

______________________________ 50/

f. Are you still taking medicine(s) for this heart trouble?

DK Yes No
9 1 2 — 51/

g. How many years ago did you last take the medicine(s)?

_____ years 52,53/

h. Why did you stop?

____

____

______________________________ 54/

____

10. Have you ever been aware of your heart beating too fast or skipping beats?

No	DK	Yes	
2	9	1	55/

11.a.Have you ever been told by a doctor that you had a stroke?

No	DK	Yes	
2	9	1	56/

b. How many years ago was this?

_____ years 57,58/

12.a.Has a doctor ever told you of any trouble with your kidneys?

No	DK	Yes	
2	9	1	59/

b. What did he say the trouble was?

______________________________ 60/

____

13.a.Have you ever been told by a doctor that you have had diabetes, sugar in your urine or high blood sugar?

No	DK	Yes	
2	9	1	61/

b. How many years ago was this?

_____ years 62,63/

Now I would like to take a second reading of your blood pressure. (Reading 2. Please record on Q. 32).

14.a. What is your present weight?

______ pounds 64-66/

b. Is this your usual weight; that is, is this what you have weighed most of the time for the last 2 years?

Yes 1	No 2	67/
c.	What do you weigh most of the time?	
	______ pounds	68-70/

15. a. In the past two years, have you been overweight?

No 2 DK 9 Yes 1 71/

b. Have you ever been on any special diet?

No 2 Yes 1 72/

c. Did your doctor recommend it?

No 2 Yes 1 73/

d. What kind of diet was it?(Circle as many as apply)

Low salt 1
Low caloric 2
Low sugar 3
Low cholesterol 4
Diabetic 5
Other .... 6 Specify ________ 74/
________ 75/

e. Did you take any reducing medicines?

No 2 Yes 1 76/

f. What is the name of the medicine(s)?

________________ 77/
________________ 78/

g. Are you taking them now?

No 2 Yes 1 79/

80/1
Card Number

1-5/ Identification Number

16. a. Have you ever smoked cigarettes? 7/ Interviewer Number

No 2 | Yes 1 8/

b. Do you now smoke?

No 2 | Yes 1 9/

c. Do you smoke:

Less than 1 pack/day?......1

One pack per day?..........2

More than 1 pack/day? 3 10/

d. What is the total number of years that you have smoked cigarettes?

_____years (SKIP TO Q. 17) 11,12/

e. When you did smoke, was it:

Less than 1 pack per day?.....1

One pack per day?.............2

More than 1 pack per day?.....3 13/

f. What is the total number of years you have smoked cigarettes?

_____years 14,15/

g. How many years ago did you stop smoking?

_____years 16/

17. a. Have you ever been told of trouble with blood circulation in your legs?

No 2 | Yes 1 — 17/

b. Was the trouble varicose veins or some other problem?

Varicose veins....1

other............2 Specify ______________________

______________________ 18/

18. a. Have you ever been told you had any form of cancer?

No 2 | Yes 1 — 19/

b. What kind(s)? ______________________ 20/

______________________ 21/

(Ask Q. 19-21 of Head of Household Only-Otherwise skip to Q. 22)

Now I would like to ask some questions about your home.

19. How many years have you lived in this house(apt.)?

_____years 22,23/

20. About how old is the building? _____years 24-26/

D.K.
9

21. a. Is there a water softening unit for your home water supply?

No 2 | DK 9 | Yes 1 — 27/

b. Is it for:

Hot water only..............1

Both hot and cold water?....2

D.K.........................9 28/

c. About how often do you add salt to the softener?

every ______months 29,30/

d. How long have you had the softening unit in your home?

______years 31,32/

Now I would like to ask you some general questions about your background.

22. In what year were you born? _____year 33-35/

23. What is the total number of years you have lived in (West Dundee/ McHenry)? _____years 36,37/

24. How many years of school have you finished?

None 1

Grade School 2

Some High School 3

High School 4

Some College 5

College Graduate.......6
(or more) 38/

25. Are you currently working, either full or part-time?

Yes, full-time.............1
Yes, part-time.............2
{ Yes, Housewife.............3
Skip to question 28{
{ No, student................4
No, not now employed.......5
No, retired or disabled....6 39/

(for "Unemployed" (5) or "Retired or Disabled" (6), ask about last occupation in Question 27).

26. a. What is (was) your main occupation or job title?

____

b. What kind of work do (did) you do, that is what are (were) your duties on this job?

____

____ 40-42/

c. In what type of business or industry is (was) this, that is, what product is (was) made or what service is (was) given?

____

____ 43-45/

d. How many years have you been employed at this job?

_____ years 46,47/

27. In what community is your job located?

West Dundee.........1
East Dundee.........2
McHenry.............3
Other...............4 Specify ____________________ 48/
____

28. SEX M F (Do Not Ask)
1 2 49/

Now I would like to ask you about your height, take your pulse and measure the thickness of the skin on your arm.

29. How tall are you without shoes on?

_____ feet _____ inches 50-52/

30. Now, I would like to take your pulse.

Number of beats in 30 seconds _____X 2 =

_____beats/min. 53-55/

31. Now I would like to measure the thickness of the skin on your right arm.

Reading 1 _____ 56,57/

Reading 2 _____ 58,59/

Now I would like to take the last measurement of your blood pressure. (Reading 3. Please record on Q. 32).

32. Blood Pressure Readings:

	Systolic	Diastolic	
Reading 1	______	______	60-62/ Systolic 63-65/ Diastolic
Reading 2	______	______	66-68/ Systolic 69-71/ Diastolic
Reading 3	______	______	72-74/ Systolic 75-77/ Diastolic
			80/2 Card Number

33. Do you have a personal physician or family doctor?

No ☐

Yes ☐

a. May I have his name, address.

Dr. ____________________

First Middle Last

____

City or Town State

☐ D.K.

Now I would like to take a sample of your tap water.

Thank you very mucl. for you assistance and cooperation.

Interviewer signature and I.D.#

____

Dated interview completed

____

APPENDIX B. LETTER TO REFUSALS

School of Public Health
UNIVERSITY OF ILLINOIS AT THE MEDICAL CENTER, CHICAGO

Area Code 312, Telephone 996-6620
Mailing Address: P.O. Box 6998 · Chicago, Illinois 60680

January 21, 1977

Recently a representative from the University of Illinois School of Public Health called at your home and was told that you were not able to participate in a very important health survey at this time. Since there might not have been time to explain the importance of your own participation in this survey, I would like to describe briefly what we have been doing in your community the last few months.

The purpose of our survey is to evaluate the possible health effects of human consumption of naturally occurring minerals found in water supplies. We are, also, re-evaluating the standards that the U. S. Environmental Protection Agency has set for these minerals.

As you know, the study is being conducted by University of Illinois interviewers. All interviewers carry credentials from the university as well as a letter of approval signed by the Mayor of your city. The interviewers ask family members, over 18 years of age, questions about their health and measure their blood pressure. *All information is kept strictly confidential!* Before leaving, a water sample is taken from the cold water tap in the kitchen for analysis. The total time for the interview is approximately 30 minutes.

In the next few days, one of our interviewers will telephone you to see if a convenient time can be made for an interview. Your cooperation would be greatly appreciated because without your assistance, we will be unable to evaluate adequately the impact of water consumption on your health.

Thank you for giving our study further consideration. If you have any questions or comments, please feel free to call me at (312) 996-8855, or write me at the University of Illinois School of Public Health, P. O. Box 6998, Chicago, Illinois 60680.

Sincerely,

Gary R. Brenniman

Gary R. Brenniman, Ph.D.
Assistant Professor
Environmental Health Sciences

GRB:lv

APPENDIX C. STANDARD ILLINOIS POPULATION, NUMBER OF PERSON YEARS USED TO CALCULATE DEATH RATES, AND AGE-SPECIFIC DEATH RATES IN ILLINOIS

Table 76 Standard Illinois Population (April, 1970)

Age (Years)	Standard Illinois Population (April, 1970)	
	Males	Females
0- 4	477,213	459,737
5-14	1,136,320	1,096,960
15-24	903,740	950,966
25-44	1,298,971	1,353,825
45-64	1,124,227	1,218,363
65+	451,365	642,289
Total	5,391,836	5,722,140

Table 77 Number Of Person Years, By Age Groupings And Sex, Used To Calculate Age-Specific Death Rates In High Barium Communities, City Of DeKalb, And Low Barium Communities For The Years 1971-75

Age (Years)	Number of Person Years (1971-75)					
	High Barium Communities		City of DeKalb		Low Barium Communities	
	Males	Females	Males	Females	Males	Females
0- 4	6,185	5,750	4,580	4,190	10,060	9,705
5-14	15,145	14,400	8,945	8,905	24,980	24,170
15-24	9,330	10,335	37,245	46,635	17,605	19,720
25-44	16,690	17,055	14,170	12,690	26,910	27,620
45-64	11,415	11,715	8,915	10,010	24,035	26,495
65+	3,675	5,470	3,340	5,120	9,515	13,710

TABLE 78 AGE-SPECIFIC DEATH RATES PER 100,000 PERSONS FOR CARDIOVASCULAR DISEASES FOR PERSONS WHO LIVED IN HIGH BARIUM COMMUNITIES (> 2.0 mg/1 BARIUM IN THE PUBLIC DRINKING WATER SUPPLY): 1971-75

Category	High Barium Communities (Barium Level > 2.0 mg/1)											
	Age-Specific Death Rates By Age Group (Years) and Sex											
	0-4		5-14		15-24		25-44		45-64		65+	
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
All Cardiovascular Diseases	0.0	0.0	0.0	0.0	0.0	0.0	41.9	11.7	735.9	256.1	6639.5	4716.6
a. Heart Disease	0.0	0.0	0.0	0.0	0.0	0.0	41.9	11.7	613.2	153.7	5224.5	3400.4
1. Arteriosclerosis	0.0	0.0	0.0	0.0	0.0	0.0	36.0	11.7	586.9	136.6	5061.2	3309.0
2. Other	0.0	0.0	0.0	0.0	0.0	0.0	6.0	0.0	26.3	17.1	163.3	91.4
b. Cerebrovascular Disease	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	52.6	59.8	1061.2	1005.5
c. General Arteriosclerosis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.5	8.5	163.3	128.0
d. Hypertension without Mention of Heart	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.1	54.4	91.4
e. Other Circulatory Disease	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	52.6	17.1	136.1	91.4
All Causes	468.9	347.8	46.2	20.8	225.1	106.4	281.6	140.7	1463.0	862.1	9986.4	6599.6

TABLE 79 AGE-SPECIFIC DEATH RATES PER 100,000 PERSONS FOR CARDIOVASCULAR DISEASES FOR PERSONS WHO LIVED IN THE CITY OF DeKALB WITH A BARIUM LEVEL > 1.0 mg/1 AND < 2.0 mg/1 IN ITS PUBLIC DRINKING WATER SUPPLY: 1971-75

Category	City of DeKalb (Barium Level > 1.0 and < 2.0 mg/1)											
	Age-Specific Death Rates By Age Group (Years) and Sex											
	0-4		5-14		15-24		25-44		45-64		65+	
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
All Cardiovascular Diseases	0.0	0.0	0.0	0.0	2.7	0.0	28.2	15.8	594.5	229.8	4640.7	3320.3
a. Heart Disease	0.0	0.0	0.0	0.0	2.7	0.0	14.1	7.9	516.0	149.9	3413.2	2031.3
1. Arteriosclerosis	0.0	0.0	0.0	0.0	0.0	0.0	7.1	7.9	493.6	109.9	3173.7	1894.5
2. Other	0.0	0.0	0.0	0.0	2.7	0.0	7.1	0.0	22.4	40.0	239.5	136.7
b. Cerebrovascular Disease	0.0	0.0	0.0	0.0	0.0	0.0	7.1	7.9	78.5	59.9	688.6	839.8
c. General Arteriosclerosis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	89.8	117.2
d. Hypertension without Mention of Heart	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	39.1
e. Other Circulatory Disease	0.0	0.0	0.0	0.0	0.0	0.0	7.1	0.0	0.0	20.0	449.1	293.0
All Causes	458.5	358.0	33.5	33.7	32.2	8.6	112.9	110.3	1032.0	739.3	7455.1	5078.1

TABLE 80 AGE-SPECIFIC DEATH RATES PER 100,000 PERSONS FOR CARDIOVASCULAR DISEASES FOR PERSONS WHO LIVED IN LOW BARIUM COMMUNITIES (≤ 0.2 BARIUM IN THE PUBLIC DRINKING WATER SUPPLY): 1971-75

Category	Low Barium Communities (Barium Level ≤ 0.2 mg/1)											
	Age-Specific Death Rates By Age Group (Years) and Sex											
	0-4		5-14		15-24		25-44		45-64		65+	
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
All Cardiovascular Diseases	0.0	0.0	0.0	0.0	0.0	0.0	55.7	47.1	719.8	249.1	5591.2	4048.1
a. Heart Disease	0.0	0.0	0.0	0.0	0.0	0.0	48.3	21.7	619.9	154.7	4277.5	2946.8
1. Arteriosclerosis	0.0	0.0	0.0	0.0	0.0	0.0	40.9	14.5	570.0	143.4	4151.3	2859.2
2. Other	0.0	0.0	0.0	0.0	0.0	0.0	7.4	7.2	49.9	11.3	126.1	87.5
b. Cerebrovascular Disease	0.0	0.0	0.0	0.0	0.0	0.0	7.4	18.1	49.9	67.9	809.2	831.5
c. General Arteriosclerosis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.1	7.5	231.2	131.3
d. Hypertension without Mention of Heart	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2	3.8	52.5	36.5
e. Other Circulatory Disease	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.2	41.6	15.1	220.7	102.1
All Causes	487.1	298.8	60.0	45.5	318.1	76.1	267.6	130.3	1364.7	785.1	8565.4	5908.1

APPENDIX D. MANTEL-HAENSZEL TEST (59)

When a random sample of disease (hypertension or currently taking blood pressure medication) and disease-free individuals is classified according to living in a high barium (HB) versus a low barium (LB) community, the distribution of this classification may be represented as follows:

	HB	LB	TOTAL
With Disease	A_i	B_i	$N1_i$
Disease-Free	C_i	D_i	$N2_i$
Total	$M1_i$	$M2_i$	T_i

Within the above subgroup, the approximate relative risk associated with the disease may be written as A_iD_i/B_iC_i. Comparison can be made with the observed number of diseased persons (A_i) living in the HB community and its expectation under the hypothesis of a relative risk of unity, $U(A_i) = N1_iM1_i/T_i$. The discrepancy between A_i and $U(A_i)$ can be tested relative to its variance which is given by $V(A_i) = N1_iN2_iM1_iM2_i/T_i^2\,(T_i-1)$. Then, the corrected chi square with one degree of freedom becomes $(|\Sigma A_i-\Sigma U(A_i)|-\frac{1}{2})^2 / \Sigma V(A_i)$. Data from Tables 29 and 18 are used to illustrate how the Mantel-Haenszel Test (59) can be applied (Table 81).

TABLE 81 MANTEL-HAENSZEL TEST USED TO DETERMINE WHETHER OR NOT THERE IS A STATISTICAL DIFFERENCE ($P < 0.05$) BETWEEN A HIGH BARIUM AND A LOW BARIUM COMMUNITY FOR THE NUMBER OF MALES WHO HAVE DEFINITE HYPERTENSION OR ARE TAKING HIGH BLOOD PRESSURE MEDICATION

Male Age Groups (years)	High Barium (HB)		Low Barium (LB)		$N1_i$ (A_i+B_i)	$N2_i$ (C_i+D_i)	$M1_i$ (A_i+C_i)	$M2_i$ (B_i+D_i)	T_i (Total)
	Disease (A_i)	Disease-Free (C_i)	Disease (B_i)	Disease-Free (D_i)					
18-24	5	72	2	52	7	124	77	54	131
25-34	9	113	4	73	13	186	122	77	199
35-44	17	75	11	63	28	138	92	74	166
45-54	27	62	21	54	48	116	89	75	164
55-64	20	49	24	53	44	102	69	77	146
65-74	14	15	52	76	66	91	29	128	157
75+	10	18	22	25	32	43	28	47	75

$\Sigma A_i = 102$

$\Sigma U(A_i) = N1_i M1_i / T_i = 98.58$

$\Sigma V(A_i) = N1_i N2_i M1_i M2_i / T_i^2 (T_i - 1) = 36.87$

Chi Square = $(|\Sigma A_i - \Sigma U(A_i)| - \frac{1}{2})^2 / \Sigma V(A_i) = 0.23$ (not significant)
(1 degree of
freedom)